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OPTIONS FOR ENVIRONMENTAL PROTECTION AND MANAGEMENT IN ONTARIO

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SUMMARY AND CONCLUSIONS

This report examines the strengths and weaknesses of three types of environmental policy instruments: "command and control" (the traditional regulatory approach in Ontario); and two types of "economic instruments", (a) those relying on prices to affect behaviour (pollution taxes, charges, deposit-refunds, subsidies); and (b) quantity instruments that use markets to allocate a fixed quantity of discharges. We explore how these can best be used individually and in combination to improve environmental quality. Our findings are based on case studies of the Ontario and international experience to date with each policy instrument, a wide-ranging literature review, and on interviews with regulators, tax policy officials, environmental groups and industry representatives.

The following are the highlights of our conclusions:

- While command and control approaches have been successful in many applications, pollution taxes, charges, deposits and discharge permit trading have proven to be useful supplements or substitutes in jurisidictions in which they have been applied. They have been able to offer significant gains in economic efficiency by minimizing the overall costs of achieving a desired level of abatement. They do not generally pose significant problems in terms of monitoring or administrative costs. In some cases, there is significant support for the use of such instruments within both industry and environmental groups.

- Due to concerns over the cost to industry, pollution taxes have generally been applied at relatively low rates as supplements to command and control programs, providing an additional incentive to meet or exceed command and control standards. Permit trading has been less successful when it has been grafted onto an existing command and control program than where it was part of the initial program design.

- There are a number of areas of environmental policy where pollution taxes, charges or deposits could be used as an effective means of altering the behaviour of large numbers of firms or households in Ontario. These include encouraging solid waste reduction, promoting the use of environmentally friendly products and discouraging the use of environmentally damaging products, and promoting responsible waste management.

- Pollution taxes offer a number of advantages as a source of government revenue, particularly in that, unlike other taxes, they discourage socially-costly activities (pollution) rather than socially beneficial activities (labour supply, etc.). Their primary disadvantages lie in the weak linkage to ability-to-pay criteria, and the fact that multiple taxes on different commodities would add to the overall complexity of the tax system.

- Should pollution taxes be used as a primary instrument for environmental protection, there would be some risk that revenue objectives, traditionally under the purview of the Treasurer, could conflict with the environmental objectives of the Minister of the Environment. Care would have be to taken in the legislation to ensure that environmental objectives remained paramount in such cases. This would not be as much of an issue where taxes were used as a supplement to command and control programs, based on the experience elsewhere. Charges that are rebated back to the industry or deposits that are refundable do not raise revenues for the province, and therefore would not create conflicts between fiscal and environmental policies.

- The use of tradeable discharge permits has proven to be an effective means of reducing environmental management costs to industry. Careful design of such programs can be used to eliminate problems that were found in early applications in the U.S. Experience elsrwhere suggests that discharge permit trading should be limited to certain classes of problems. A number of potential uses in Ontario, particularly in air quality management, appear worthy of further, detailed consideration.

SUMMARIES OF KEY CHAPTERS

Ch3: Case Study Evidence

- The case study evidence demonstrates that differences in the characteristics of the environmental problem being addressed (e.g. number of sources, previous regulations, abatement cost conditions etc.) have led to a mix of successes and failures for each type of instrument.

- **Command and control** instruments have received both praise and criticism. We examine two case studies: Ontario's Countdown Acid Rain program for sulphur dioxide emissions from major point sources, and the control of BOD effluents from pulp and paper mills in Ontario.

- The two case studies examined showed that total abatement costs tend to be higher than might be necessary to achieve a target ambient environmental quality. Abatement timetables tended to be lengthy, in part reflecting the case-by-case, negotiated approach to standards setting, and in part attributable to a desire to allow for technological development. At the same time, in both cases it was clear that a wholesale shift to economic instrument approaches would offer both advantages and difficulties, particularly where the command and control process is well advanced and where local pollution problems are important.

- **Quantity-based economic instruments**, such as marketable discharge permits, have primarily been applied in the U.S. We examine three such applications: tradeable lead content permits for gasoline, emissions trading under the Clean Air Act, and trading for effluents into the Fox River.

- In the case of the phase-out of lead in gasoline, the nature of the industry, and an effective program design, resulted in a faster, more cost-effective phase out than was likely to have been achievable under command and control. The more restrictive trading program for emissions under the Clean Air Act resulted in less trading volume, somewhat disappointing cost savings, and some initial problems (subsequently addressed) in avoiding negative environmental impacts. However emissions trading still offered some gains over command and control on balance. Trading for Fox River water pollution control failed due to severe restraints placed on trades and the small number of sources.

- Monitoring, administrative and enforcement costs were not a barrier to the use of permit trading in these cases. There was only minor evidence of beneficial impacts of this approach for innovation or technical change.

- **Price instruments** (pollution taxes, charges, deposits) have been extensively used internationally, most often as supplements to command and control. We examined three cases: wastewater effluent taxes in three European countries, taxes on leaded gasoline in Ontario, and variable charges for household garbage in Seattle and other U.S. locations.

- Price instruments were found to be very effective in cases where abatement costs are relatively modest (e.g. discouraging improper use of leaded gasoline, promoting container returns, reducing household solid waste), but rates are typically set too low (due in part to industry impacts of high rates) to be used as the major incentive for

abatement where marginal abatement costs are high. In these latter cases, they have primarily been used as a supplement to command and control, providing a financial incentive to exceed or meet a given standard. They generally are reasonably cost effective to operate, and can be constructed with the same monitoring procedures as used in command and control.

Ch 4: Economic Instruments in Other Policy Fields

- Although not extensively used in Canadian environmental policy, economic instruments have been successfully employed in other policy fields in Ontario. We examine two such cases in this report.

- Taxes on cigarettes were found to have had a marked disincentive effect on smoking in Canada, operating in a similar fashion as pollution taxes.

- Marketable permits for milk production have enabled the Ontario Milk Marketing Board to control the overall volume of milk production (analogous to total discharges into the environment), while enabling trading that permitted the milk to be produced in a more efficient mix of farms (analogous to cost-saving improvements in the allocation of total abatement efforts).

Ch 5 Overall Evaluation of Price Instruments

- Price instruments have had mixed performance in terms of protecting the environment. They work best where governments are able to impose sufficiently high rates to induce an abatement response, where behaviour is very price sensitive, where the environmental medium into which discharges occur is well mixed, and where damage is not subject to major threshold effects. Chapter 5 details the types of conditions that make high rates and price sensitivity more likely. Price instruments are unsuitable as the primary control method for highly toxic substances in need of immediate elimination, highly source-specific discharges, or where the action being taxed is imperfectly linked to the damage to the environment.

- Price instruments offer the potential for significant abatement cost savings over command and control. These advantages are diminished where there are threshold effects, non-perfect mixing in the medium, and uncertainty over abatement and damage costs.

- There are no clear findings on the relative ability of regulators to adjust command and control vs. price instruments over time. Price instruments can be changed more quickly, and generate automatic increases in abatement efforts if abatement costs fall. However, price instruments suffer due to the need to constantly increase them over time to maintain the real value of the incentive in the face of inflation, and also can result in conflicts between changes desired for environmental reasons and government revenue objectives.

- Price instruments are thought to be more likely to promote the use innovative approaches to abatement, but there is limited evidence on this point. They may be less likely to promote the diffusion of new technologies than command and control.

- Price instruments may promote more in-house R&D by polluters, but command and control offers strong incentives for R&D by outside suppliers who can develop the "best available technology", the use of which can be compelled by regulators.

- Monitoring and enforcement costs do not appear to be a major problem for the use of price instruments. Monitoring can be best on the same types of self-reporting and spot monitoring now used in Ontario. The exception may be for pollution subject to strong threshold effects, where command and control does not require monitoring to be accurate if ambient quality or discharges at a given source are below a certain threshold. Some variations of price instruments can be used to avoid the need for monitoring below a threshold in such cases.

- Industries will generally, but not universally, oppose the use of price instruments, particularly pollution taxes that represent a net increase in the sector's tax burden. Environmental groups would be highly supportive of their use in selected types of problems (solid waste management, conservation, etc.) and opposed in other cases. Ministry of the Environment staff interviewed for this study vary in their views, with the greatest support being found in the waste management field.

- The use of price instruments, particularly pollution taxes, could result in a sharing of environmental policy authority between the Ministry of the Environment and the Ministry of Treasury and Economics that typically has a role in setting tax rates. Care would have to be taken in the design of such instruments to ensure that the rates were set to reflect environmental as opposed to revenue objectives. (For example, the legislation could provide for adjustments to the rates to be made where given targets for abatement have not been achieved.) Alternatively, price instruments could be used only as a supplement to command and control regulations, (as has been the case in all of the jurisdictions examined in our case studies with the exception of taxes on household garbage). This would enable the Ministry of the Environment to retain the authority to set a minimum performance standard for sources, while allowing the price instrument to create an incentive to meet or exceed it.

- Pollution taxes may be an effective substitute for existing government revenue sources that tend to impose greater economic efficiency costs. They can, however, be regressive when imposed on the public, and may be less well linked to ability-to-pay than corporate income taxes. Other advantages and disadvantages of these taxes are explored in Chapter 5.

- Pollution taxes can impede industrial competitiveness relative to jurisdictions not imposing them. Methods of cushioning this impact are reviewed in our report.

Ch 6 Overall Evaluation of Quantity-based Economic Instruments

- Quantity-based instruments involve the use of permits for discharges, which may be issued free and then traded among pollution sources or auctioned to them.

- These instruments are generally designed to match, rather than exceed, the environmental performance of command and control. They can be superior to command and control in explicitly addressing the impact of economic growth on total emissions. As with price instruments, they perform less well in certain circumstances: e.g. where the environmental medium is not well mixed, or where there are important differences in the composition of discharges among sources, or where the discharges are very hazardous and have to be completely and immediately eliminated.

- Permit trading can produce impressive abatement cost savings relative to command and control. These advantages are in some cases eroded by many of the same factors that

were discussed for price instruments. Some, but not all, permit schemes can have adverse consequences for barriers to entry for new firms, and could result in a lack of competition in product markets in cases where permit holders are all in the same, concentrated industry.

- Permit trading systems may be less easily adjusted by regulators facing unforeseen needs to alter discharge levels than command and control, but can offer greater flexibility for firms in terms of their timetables for adjusting to regulations.

- The implications of quantity-based systems monitoring and enforcement costs, innovation and R&D are similar to those discussed for price instruments, except that the latter are easier to administer where the number of sources is very large.

- Industries tend to be more supportive of these instruments than price instruments. The method of allocating permits has an important bearing on industry views, with firms favouring free issues over auctions, for example. Ministry of the Environment regulatory staff and environmental groups are less supportive of these instruments than price instruments.

- The cost savings achieved through permit trading offer advantages for Ontario's industrial competitiveness. Auctioning of permits raises funds in a similar fashion to pollution taxes, so the implications for competitiveness and performance as a revenue instrument are also similar to our discussion for price instruments.

Ch 7 Framework for Selecting Environmental Policy Instruments

- Chapter 7 develops a framework for evaluating the performance of command and control and various economic instruments based on 28 characteristics of the environmental issue involved. These characteristics relate to the nature of the contaminant, the medium into which discharges occur, abatement costs and technologies, monitoring technologies, the sources of the discharges, the state of the existing regulatory climate, and government policy objectives. Table 1 lists the criteria examined in our framework.

- We use this framework to explore the merits of economic instruments to selected environmental problems in air pollution, water pollution, hazardous waste and solid waste management. Ground level ozone problems are used to illustrate the factors that would be considered in selecting an instrument in a particular case.

- Price instruments appear to hold considerable promise in solid waste management, and as a supplement to command and control in hazardous waste management. Permit trading might be used to reduce packaging wastes if voluntary reductions are insufficient, and deposit-refund systems could be expanded. Marketable permits are already being explored for emissions trading of NOx, but may be less desirable for VOCs. Sulphur dioxide trading has some potential, particularly if controls are extended beyond those now mandated by the Countdown Acid Rain program. A range of command and control approaches and economic instruments could be used if and when measures are taken to address the greenhouse effect. Water pollution control has less scope for economic instruments to supplant command and control due to the local nature of pollution problems, but there is some scope for effluent trading, and the use of price instruments as a supplement to command and control.

Table 1
Factors Examined in Policy Framework

Nature of Contaminant
- Toxicity
- Damage function
- Variability
- Homogeneity of discharge
- Link between production / consumption and damage

Nature of Medium
- Mixing
- Transboundary flows

Nature of Abatement Technology
- Regulator's knowledge
- Homogeneity by source
- Techn. change
- Abatement options

Nature of Abatement Costs
- Cost differentials by source
- Magnitude of costs
- Certainty of costs

Nature of Other Policy Objectives
- Conservation objective
- Revenue objective

Nature of Monitoring Technology
- Cost

Nature of Sources
- Number
- Out-of-Province competition
- Financial performance
- Public / Private sector
- Interfirm linkages
- Economic growth
- Monopoly power

Nature of Existing Regulations
- Jurisdiction
- Extent and effectiveness
- Industry resistance
- Knowledge of discharges

1. INTRODUCTION

1.1 Background

The protection of the environment has become a major area of public policy in Ontario, with several new initiatives addressing air, water and solid waste management in the province. For the most part, these initiatives are taking the form of regulations setting out standards for discharge levels, in some cases requiring the virtual elimination of toxic substances.

Many of the items that remain on the environmental agenda pose particular challenges for the design of policy approaches. In air quality management, for example, in contrast to the relatively more modest number of major point sources previously regulated for total SO_2 emissions, achieving improvements in particulates, volatile organic compounds, or greenhouse-effect gases such as CO_2 would require behavioural changes by nearly all segments of industry and households. This may mean that setting and enforcing standards is an impractical way of addressing this issue. Similarly, while regulations can be useful in establishing procedures for solid waste treatment and disposal, efforts to address waste reduction and recycling bring a much larger number of agents under the purview of the Ministry's policies.

There is also an increasing awareness among economic policy-makers of the inherent relationships between various aspects of environmental management and the economic climate. There are several such linkages currently gaining close scrutiny, including:

- the concept of "sustainable development", which directly addresses the relationship between economic growth and environmental quality;
- the potential use of "environmental taxes" as a means of achieving simultaneously both environmental goals and fiscal policy objectives relating to controls on deficit financing in a period of increasing demands on government; and
- the need to assess the "economic achievability" of environmental objectives, and the desire to achieve environmental objectives in a manner which promotes the efficient allocation of resources, including the examination of the international competitiveness implications of tightening environmental standards.

For many years, economists and environmental policy analysts have explored the potential use of economic instruments as an alternative means of achieving environmental objectives. These alternatives included taxes on effluents, user fees, the creation of a market for emissions in which the right to emit specified quantities of a given pollutant could be bought and sold, and other economic instruments relying on individual reactions to specific incentives and disincentives.

Initially, proponents argued that market-based approaches could be used to generate incentives for pollution abatement, and that such policies, at least in theory, were superior to direct regulation on both economic and environmental grounds.[1] Later modifications to the theoretical research suggested that under less idealized conditions, there would be cases where economic instrument approaches would be inferior to traditional command-and-control regulations.[2]

Thus, the practical merits and demerits of economic instrument and command-and-control remain in dispute and approaches cannot be fully evaluated based on theoretical grounds. An empirical review of how these approaches work in practice is therefore necessary to guide future policy-making in Ontario.

1.2 Purpose

The purpose of this study is to develop a framework that can be used to determine the applicability of economic instruments in future policy decisions, based on the characteristics of the environmental problem under consideration. To reach this objective, we review the status quo mix of "command-and-control" and "economic instruments" in Ontario environmental policy, and assess the strengths and weaknesses of various policy mechanisms against a range of criteria based in part on past experience in environmental protection and other fields of government policy in Ontario and other jurisdictions. In view of the breadth of the scope of our study, we were not asked to design a specific economic instrument approach to any given environmental policy.

Since much of the extensive *theoretical* literature on this topic is already well-known to both the Ministry of the Environment and the Ministry of Treasury and Economics, the focus of this study is on the practicality of the various approaches to Ontario environmental

[1] See, e.g., Dales (1972)
[2] See Hahn (1990) for citations to this extensive literature. We return to this issue in Chapter 5.

policy, based on *empirical* evidence of how such policies have performed in the past in Ontario and elsewhere.

1.3 Organization of this Report

Including this Introduction, this report comprises seven chapters. Chapter 2 reviews the methodology and definitions used in the study. Chapter 3 documents and assesses the experience of Ontario and other jurisdictions with command-and-control and economic instrument approaches in a wide range of cases. Chapter 4 briefly surveys the use of economic instruments in other fields of regulation in Ontario. On the basis of these cases, interviews and previous analyses on instrument choice in environmental policy, Chapters 5 and 6 develop overall conclusions on the merits of price and quantity-based economic instruments relative to command and control. Chapter 7 then provides a framework for classifying environmental problems and determining the applicability of economic instrument approaches to them.

2. METHODOLOGY AND DEFINITIONS

2.1 Sources

This report draws upon a diverse range of sources to reach conclusions on the efficacy of various environmental policy mechanisms.

Interviews were conducted with various stakeholders in environmental policy in Ontario, including representatives of the Ministry of the Environment, environmental groups and industries subject to environmental regulations.

Literature and data on the performance of environmental policies were assembled and reviewed. Experts in Canada and abroad were contacted to fill in gaps in the literature. A list of references is appended to this report.

2.2 Criteria for Evaluation

Our empirical analysis of economic instruments and command-and-control instruments evaluates the programs under study according to ten criteria. These were set out in the original design for the study by the Ministry of the Environment and the Ministry of Treasury and Economics, and we believe them to be reasonably complete. In each case, to the extent that data and evidence permit, we draw conclusions on the following nine criteria:

1) *Capacity to protect and improve environmental quality*: Our role is not to assess the merits of the targets set by governments, only the extent to which the policies have been effective in meeting them.

2) *Efficiency in resource allocation by polluters*, i.e. the extent to which the policy has directed the resources of polluters in a cost effective manner towards abatement and control, and takes into account the differences in abatement costs and environmental damage per unit of discharge.

3) *System adaptability*, which captures the ability of regulators to accommodate social, economic, technological and environmental changes through appropriate and timely adjustments to the program.

4) *Capacity to generate technological innovation*, i.e., the extent to which companies can be induced to *implement* new technology to solve an environmental problem.

5) *Capacity to induce research and development*, which relates to the extent to which firms are given private incentives by the structure of the regulatory approach to undertake pollution control R&D investments.

6) *Requirements for cost of and frequency of monitoring, enforcement and administrative activities.*

7) *Public, private sector and interest group perception*, which captures the degree of support or resistance to a particular approach to regulation from these various segments of society.

8) *Suitability and effectiveness as public financing mechanisms*, which relates to the utility of some approaches in providing general revenues or funds to finance environmental programs.

9) *Implications for international trade competitiveness*, which relates to the impact of pollution control costs (including administrative costs, effluent fees, etc) on the ability of firms to compete against others in jurisdictions with differing environmental policies.

2.3 Defining "Economic Instruments" and "Command-and-control"

2.3.1 Definitions

This study is directed at comparing a class of environmental policies that use "command-and-control" approaches with policies employing "economic instruments". Since these terms are potentially subject to differing interpretations, it is useful to establish at the outset a clear definition for each type of approach.

"Command-and-control" approaches to environmental regulation are those that require a fixed set of actions by a firm or individual, using the force of law to ensure compliance. The set of actions could range from requirements to meet certain emissions targets, employ particular abatement equipment or processes, abide by zoning restrictions,

and so on. The court system or other quasi-judicial body is used to enforce the regulations, through fines, shutdowns, prison terms, or other penalties.

Opschoor and Vos (1989) defined "economic instruments" as policies that "affect estimates of costs and benefits of alternative actions open to economic agents, with the effect of influencing decision making in such a way that alternatives are chosen that lead to an environmentally more desirable situation than in the absence of the instrument".

In practice, the two alternative mechanisms are not entirely distinct, with most policies having at least some elements of these two archetypical approaches. For example, command-and-control regulations enforced by fines can be thought of as being in part an economic instrument, since the fine provides the incentive to comply. The distinction in this case is that even where fines are used, the government typically has a final power to shut down a facility or use the courts to enforce a set of actions deemed to be "compliance", while an economic instrument approach leaves the firm the possibility selecting its own actions. Subsidies to reduce the costs of abatement, which could be viewed as an economic instrument approach, are often employed only as a means of helping firms to meet a more stringent standard expressed in a command-and-control regulation in the short run.

It is important to distinguish the concept of an economic instrument with two other concepts with which it could potentially be confused. First, economic instrument policies do not imply an attitude of "laissez-faire" – letting the market alone determine the degree of environmental protection. Rather, economic instruments entail specified interventions into the free market in order to create the appropriate incentives and disincentives. Only the most idealized economic theories would suggest that merely assigning property rights (e.g. the right of an individual to sue a polluter for damage to his property or health) would enable the free market to adequately protect the environment.[3] Once one recognizes the difficulties entailed in establishing damage claims, the costs of litigation, the transactions costs involved where the number of affected parties is large, it is clear that a laissez-faire approach would provide inadequate protection for the environment. Dewees and Trebilcock (1991) conclude that the tort system (suits over injuries caused by environmental neglect) has not played a major role in deterring polluting behaviour or in compensating those injured by pollution.

[3]The idealized result is generally termed the "Coase Theorm", based on the work of the University of Chicago economist of the same name.

Second, economic instruments need not entail the use of a formal "cost-benefit analysis" in setting environmental objectives. It is the firm or individual responding to a policy that makes trade-offs between monetary payments or rewards and environmental actions. From the policy-maker's perspective, *any* objective or target for environmental quality or abatement efforts can be achieved using economic instrument approaches.[4] Thus governments do not necessarily have to make trade-offs between economic and environmental goals as a part of a policy-making process using economic instrument approaches.

2.3.2 Types of Economic Instruments

The definition of "economic instruments" provided above becomes more apparent with an enumeration of the types of economic instrument policies that typically are suggested or employed for environmental protection purposes. Opschoor and Vos (1989) provided a categorization, which we have adapted slightly for the purposes of this report.

Several approaches can be broadly termed to be **price instruments.** These instruments set a price (negative in the case of a subsidy) to be paid by an economic agent based on activities related to the environment, but leave the degree of emissions or abatement activity up to the individual firm or household:

- **Charges / taxes** - prices paid by a polluting firm or individual. These policies include: effluent or emission charges based on the quantity of discharges; user charges for public sector services related to waste treatment or disposal; product charges or taxes levied on purchasers or suppliers of environmentally-damaging goods or services; reductions in the usual sales tax burden for environmentally-friendly products or services. These policies create an incentive for abatement by increasing the cost of a polluting activity.

  For the purpose of this report, we will use the term "charges" to denote fees that are used for a targetted environmental purpose, and "taxes" to refer to fees where the funds raised are added to general revenues.

- **Subsidies** - grants, low interest loans or tax allowances for environmentally beneficial activities. These policies create an incentive for abatement or recycling by reducing the cost of an abatement activity. For the purposes of this study, where such subsidies are merely a financial support for the purpose of meeting command-and-control based policies which are non-voluntary (i.e. enforced with legal

[4]Although, as we discuss in our findings, the practical merits of such approaches depend in part upon the type of abatement effort desired.

penalties for violations), they will not be viewed as being an "economic instrument" policy. Only where the firm or individual is free to respond to the subsidy is this a true economic instrument approach to protecting the environment. Similarly, fines or performance bond payments for non-compliance are an enforcement mechanism for command-and-control, not an economic instrument approach.

- **Deposit-refund systems** - prices paid and then refunded if certain actions are followed, such as the proper return of a beverage container. These can be viewed as either increasing the cost of a polluting activity (the individual foregoes a refund) or reducing the cost of abatement (the refund is an incentive to return the container). Ontario's financial assurance system is also an example of a deposit and refund, since landfill operators are refunded the amounts posted if they meet certain performance standards.

- **Liability systems** - making clear rules on the liability of polluters for damages caused to others by their activities, sometimes supplemented by requirements that firms carry insurance against these liabilities. The price paid for the insurance creates an incentive for such activities as spills avoidance investments, for example.

Another class of instruments can be grouped as **quantity instruments**. These enable the policy-maker to set the maximum discharges or minimal standard for total abatement, but allow for economic forces to determine the means to achieve the objectives and the price to be paid (or incentive to be received) for polluting (or abatement) activities:

- **Emissions or Effluent trading**[5] - setting a fixed quantity for total emissions in a specified area and allowing firms or plants of a single firm to trade these rights. This fixes the total quantity of pollution, and creates an incentive for firms to abate beyond any initial reduction based on the market price established for permits.

- **Emissions or effluent auctioning** - similar to emissions trading, except that permits are initially auctioned to the highest bidder rather than issued free to existing polluters.

[5] In principle, one could have a trading system for waste disposal or waste generation rights. We have not identified any jurisdiction that has used such a system.

3. CASE STUDIES ON ALTERNATIVE ENVIRONMENTAL POLICY APPROACHES

3.1 Introduction

Environmental objectives can be achieved using a variety of policy mechanisms. The choices that must be made between the various types of instruments for environmental policy cannot always be clearly distinguished on theoretical grounds. Thus, one must turn to the history of how various instruments have performed in practice in order to develop sound principles for the choice of policy instruments in the future.

Ontario has generally attempted to meet its environmental goals using the "command-and-control" approach. As a result, there is considerable experience with these types of regulatory instruments in the province. However, the history of economic instruments as environmental policy tools in the province is rather limited, and one could not reach conclusions on their applicability based on Ontario or even Canadian experience alone.

Fortunately, a number of other jurisdictions, most notably in Europe and the United States, have experimented with economic instrument approaches to environmental policy for more than a decade. The successes and failures of these policies, when added to the evidence from Canada, assists us to developing a set of principles on the types of environmental problems most suited to alternative approaches.

In this Chapter, we evaluate a number of cases of environmental policies using both the economic instrument and command-and-control approaches, closely following the criteria listed in above. Each case provides useful observations on the successes and failures of various approaches to different classes of environmental problems. We draw heavily on the practical guidance provided in these cases in subsequent parts of this report to reach more general conclusions on the potential application of economic instrument approaches in Ontario. We leave the discussion of these general findings to a subsequent chapter, which also makes use of our understanding of a much larger number of cases which, in the interest of brevity, we do not review here.

Prior to the *empirical* review that forms the core of this Chapter, we briefly summarize how the approaches are thought to differ on these criteria *in theory* , in order that the reader can bear in mind these theoretical considerations when reviewing the practical experience.

3.2 Conceptual Considerations

A large body of literature exists on the theoretical advantages and disadvantages that economic instruments have to offer for environmental policy. While we do not attempt to provide a detailed, annotated review of this literature, in this section we briefly review some of the principal conclusions of theoretical work in the field in terms of its implications for each of the criteria presented in Chapter 2:

1) *Capacity to protect and improve environmental quality*: Environmentalists have sometimes argued that economic instrument approaches enable firms to avoid technically feasible abatement activities by purchasing permits or paying fees. Proponents of market based systems maintain that they merely allow any given overall abatement target to be most cost-effectively achieved, and thereby allow regulators to choose more stringent overall targets without causing economic difficulties. We discuss these issues in much more detail in our case examinations below.

2) *Efficiency in resource allocation by polluters*. Economic instrument approaches, at least in theory, are thought to offer advantages in terms of allocating resources to abatement where the costs of abatement are lowest and/or where the damage to the environment is greatest. At the same time, command-and-control programs might not be as inefficient as the "theoretical strawman" often used to promote economic incentives in theory work, if only because policy-makers may take economic criteria into account when setting control orders on individual plants.

3) *System adaptability*. Market-based approaches can make use of changes in emissions fees or permit tonnages to alter the stringency of regulations in response to changing technologies or environmental conditions, and in theory these may be easier to accomplish than the protracted review and negotiations on new regulations for each type of source in a command-and-control system. Market approaches such as charges or taxes will tend to automatically induce greater abatement efforts when technological improvements lower abatement costs, while command-and-control methods may require regulatory changes to induce these efforts.

4) *Capacity to generate technological innovation.* Economists have argued that in theory economic instrument approaches are preferable on this ground to command-and-control methods that often rely on requiring the use of specified technologies (e.g. best-available control technologies).

5) *Capacity to induce research and development.* Again, economists have favoured market-based approaches, on the grounds that R&D that yields a cost-effective control technology will give a firm an opportunity to either generate emissions credits for sale or to reduce its payments of emissions charges. However, command-and-control methods may also provide R&D incentives, since firms wish to anticipate future regulatory tightening in order to have the "best available technology" to sell to others.

6) *Requirements for cost of and frequency of monitoring, enforcement and administrative activities.* While some economists argue that economic incentives require lesser data requirements, others suggest that high charges for discharges will create the need for very precise monitoring by both government and industry. We discuss our findings on this issue in Chapter 5.

7) *Public, private sector and interest group perception.* It is commonly felt that the clarity of command-and-control instruments makes them more attractive to environmental groups and regulators, and the former are also generally felt to be resistant to the creation of so-called "markets in pollution". Industries may favour the cost-effectiveness of economic instruments, but oppose polluter-pay systems such as effluent charges or taxes.

8) *Suitability and effectiveness as public financing mechanisms.* Effluent charges, taxes and auctions for emission permits can raise revenues as a supplement to, or substitute for, existing sources of government revenue. In addition to environmental benefits, the advantages of such mechanisms include i) their consistency with a "user-pay" or "polluter-pay" principle; and ii) by discouraging activities with an economic cost (in environmental damage), they are substitutes for other taxes that discourage productive behavior (labour supply or investment). Some of the disadvantages cited relate to equity goals, since such taxes may be poorly related to ability to pay, and the fact that rate setting can involve a compromise between

government revenue objectives and environmental goals. Other goals for taxation, including simplicity and balance among revenue sources, will be affected positively or negatively depending on the specific design of an environmental tax.

9) *Implications for international trade competitiveness.* Minimizing the total costs to the economy for pollution control, and the resulting improvement in industrial competitiveness, is one advantage cited for marketable permit systems in the theoretical literature. Effluent charges, taxes or permit auctions impose an added financial burden on firms above and beyond the cost of abatement (since firms with non-zero discharges will have to pay taxes or purchase permits). However, where these taxes serve as substitutes for traditional corporate tax revenues, the net tax burden on private industry as a whole should not change. In addition, dealing with regulators imposes costs on firms in a command and control system. Permit systems that grant rights to existing firms may create entry barriers for new competitors and thereby reduce competition in the market. Finally a clean environment, however achieved, can be a benefit in terms of a jurisdiction's ability to attract tourist facilities, head-offices and other investments, and to retain and attract skilled labour.

3.3 Emissions/Effluent Trading Programs Case Studies

3.3.1 Introduction

Emissions or effluent trading programs, also known as "marketable permits systems", involve the creation of a market for trading a restricted quantity of rights to discharge substances into the environment. Such rights, although not saleable, are implicit in any command and control program that does not legislate a zero discharge requirement. In emissions or effluent trading programs, the ability to sell or purchase rights enables a market system to determine the means by which a given total target for abatement will be achieved by individual firms or municipalities.

In this section, we review the use of marketable permits in three applications: the reduction of lead content in U.S. gasoline, the reduction in various emissions under the U.S. Clean Air Act, and the abatement of effluents into the Fox River in Wisconsin. The first of these applications, the only pure application of marketable permits with no major

constraints on trading, was highly successful on both environmental and economic grounds. The second example, using a mix of emissions trading and command and control, was somewhat less successful overall. The third example, again a mixture of trading system and command and control, must be generally viewed as an example where trading failed to achieve its potential.

3.3.2 The U.S. Lead Trading Program

The United States has been one of the most innovative countries in terms of the use of certain types of economic instruments for environmental protection. Although environmental taxes and charges have not been applied to the same extent as in Europe, there have been several experiments with marketable permits and other quantity-based approaches. U.S. evidence on these approaches is thus an important source for the evaluation of their potential application in Ontario.

The U.S. experience under the lead trading program is an excellent case study of the successful use of economic instruments in the phased, virtual elimination of an environmental contaminant, in this case, lead in motor vehicle fuel. Ontario has targetted a number of environmental contaminants, particularly those that are persistent toxins, for virtual elimination from the biosphere. This case serves to demonstrate the potential use of economic instrument approaches where the ultimate goal of environmental regulation entails an elimination or near-elimination of a product or emission.[6]

History and Description of the Program

Lead has long been recognized as having adverse health effects on humans, particularly children, and leaded gasoline was historically an important source of airborne lead. The improper use of leaded gasoline can also damage catalytic converters used to reduce other motor vehicle emissions. For these reasons, both in Canada and the United States, programs have been put in place to phase out the use of lead as an anti-knock additive in gasoline.

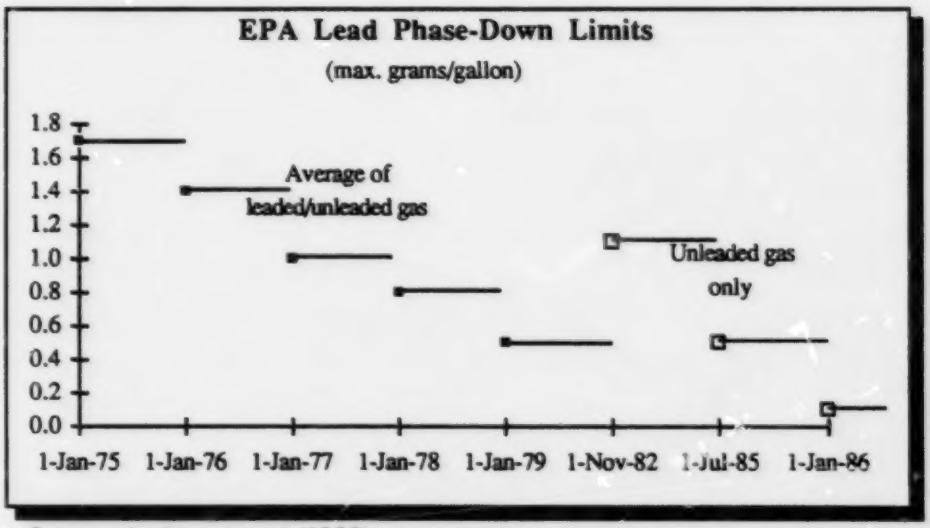
The initial steps taken by the EPA in the United States to reduce the lead content in gasoline used a command-and-control approach. The initial regulations limited the lead content in leaded gasoline to 1.7 grams/gallon as of January 1, 1975 and required unleaded

[6]The following analysis draws heavily on Anderson et al (1989), as well as NERA (1990) and Moore et al (1989).

gasoline to be made widely available. A five-year phase-down schedule was established, based on an estimate of the pace that could reasonably be achieved, with the company-wide average (leaded and unleaded gasoline) lead content of each refiner restricted to 0.5 grams per gallon by 1979. Note that this program had an element of *intra-firm* emissions trading, since a company could trade-off reductions and increases in the lead content of individual refineries it owned, and also make trade-offs between unleaded gasoline sales and the lead content in leaded gasoline.

While this program worked well in terms of meeting lead content reduction targets, most of the required reductions were achieved as a result of the increasing sales of unleaded gasoline, rather than by reductions in the lead content of leaded gasoline. By the mid-1980s, further reductions in lead emissions would primarily have to come by moves to reduce the lead levels in leaded gasoline.

Figure 3.1



Source: Anderson et al (1989)

In October 1982, new regulations were issued by the U.S. EPA that would limit the lead content in leaded gasoline, with a phase-out from an initial ceiling of 1.1 grams/gallon to a target of 0.1 grams/gallon (the minimum required to avoid engine damage on cars requiring leaded gasoline) after January 1, 1986.

Inter-firm lead trading was first instituted in July 1983, when the U.S. EPA allowed inter-firm averaging of lead use. The averaging provisions were introduced

because the U.S. EPA recognized, based on industry input, that some refiners would face high adjustment costs to a rapid phase-down, but there was a desire not to hold up the phase down schedule solely for the benefit of these refiners.

Under the program, a refiner or importer could exceed the maximum allowable lead content if it purchased rights from another refiner or importer whose lead content fell the same degree below U.S. EPA limits. Trading would be allowed during the phase-down period, with no trades permitted after January 1, 1986 (since any gas produced with less lead than 0.1 would be harmful to leaded-gasoline cars).

To be precise, as discussed by Hahn (1989) and Anderson (1989), the trades worked as follows: When the standard was, say 1.1 grams/gallon, if a firm produced 100 gallons in a quarter, it received (free of charge) the rights to use 110 (i.e. 100 X 1.1) grams of lead. If it wished, it could sell nearly all of this lead to another refiner, up to a limit of 100 grams (= 110-10, since it must use a minimum of 10 grams per 100 gallons, in leaded gasoline). Hahn points out that, in contrast to emissions permits for acid gases in the Clean Air Program, being a large *past* producer of lead did not grant a firm any explicit advantage. Even so, the granting (as opposed to auctioning) of rights was an important element in gaining industry support for the program. More details on the administration of the program are provided below.

Banking of lead rights was a feature added to the program in 1985. Under the banking provision, a firm that had a lead content below the allowable limit during any quarter in 1985 could exceed the limit by an equal amount in any quarter from 1985-87. Thus, a firm planning to exceed the phase-down ceilings in a given quarter of 1985 had an option of either selling the rights to another firm or banking the rights for its own use in subsequent quarters.

The banking provisions were instituted to permit added flexibility in the face of impending violations of the lead phase down program. As the deadline for near-zero lead content rapidly approached, it was increasingly evident that some refiners were likely to fall short of the target. Rather than merely allow excess lead emissions overall with no environmental benefit, the U.S. EPA sought to promote a more rapid phase down in 1985, in exchange for an equivalent additional lead emission in 1986-87.

Evaluation of the Lead Trading Program

The lead trading program has been widely viewed as a successful application of an economic instrument approach to environmental protection. As we demonstrate below, the program generated significant cost savings for refineries and provided the flexibility necessary to enable a rapid reduction in lead usage.

i) capacity to improve environmental quality

The results of the lead trading program indicate that it had no major adverse impacts on environmental quality, and that it may have enabled regulators to push for a more rapid phase out of lead use than would otherwise have been the case.

The overall regulatory program instituted by the U.S. EPA succeeded in dramatically lowering the lead content in gasoline. However, the extent to which the lead trading and banking features of the program served to achieve these goals is less clear. Anderson et al (1989) as well as Moore et al (1989) conclude that there were no adverse effects on overall environmental quality attributable to lead trading, although the former notes that trading across regions may have resulted in higher airborne lead emissions in some locations where refiners were heavy buyers of lead rights. This sort of inter-regional difference in impact was not likely a major problem in a short-duration program such as this one, but is a factor in longer term effluent trading where local exposures are a factor.

Banking improved the lead emissions in 1985 at the expense of greater emissions into 1986-87. However, banking was instituted because a number of refiners were not in a position to meet the original phase-out schedule, and there would likely not have been a sufficient supply of credits in 1986-87 to meet their needs. Thus, one might argue that in the absence of banking, the phase out schedule would not have been met in any event in 1986-87, and that the net effect of banking was to trade the inevitable emissions in 1986-87 for an improvement in performance in 1985.

One possible environmental benefit from this type of effluent trading program is the extent to which the U.S. EPA's regulatory targets may have been influenced by the permit program, since the added flexibility in an economic instruments approach can in some cases reduce industry resistance and economic costs.

In this case, in terms of the final target for lead content in the post-phase-out period, the availability of an economic instrument approach does not appear to have had any

impact. Hahn (1989) in fact attributes part of the program's success to the fact that it "was implemented after agreement had been reached about basic environmental goals. In particular, there was already widespread agreement that lead was to be phased out of gasoline."

However, it does appear that the timing of the phase-out was accelerated by the availability of trading and banking to reduce the costs to refiners that could not adjust as quickly as others in the industry. A U.S. EPA official contacted for this study judged that there was a "modest" impact on the phase-out schedule attributable to the lead trading system, since overall industry support for the program was enhanced and the political resistance to a rapid phase-out was thereby muted. NERA (1990) argues that the impact was more dramatic, and that there had been considerable skepticism that the tight timeframe was achievable in the absence of the trading and banking program. In their view, the ability to use trading and banking to accelerate the overall timetable was critical to winning support for the program from U.S. EPA bureaucrats, who could have otherwise blocked the use of trading in this context.

ii) efficiency in resource allocation by polluters

This criterion assesses the extent to which the overall costs to the economy of achieving the desired reduction in lead content in gasoline were reduced through the use of the trading program. The evidence suggests that in fact there were significant savings realized over a system that required all refiners to reduce lead use at the same rate.

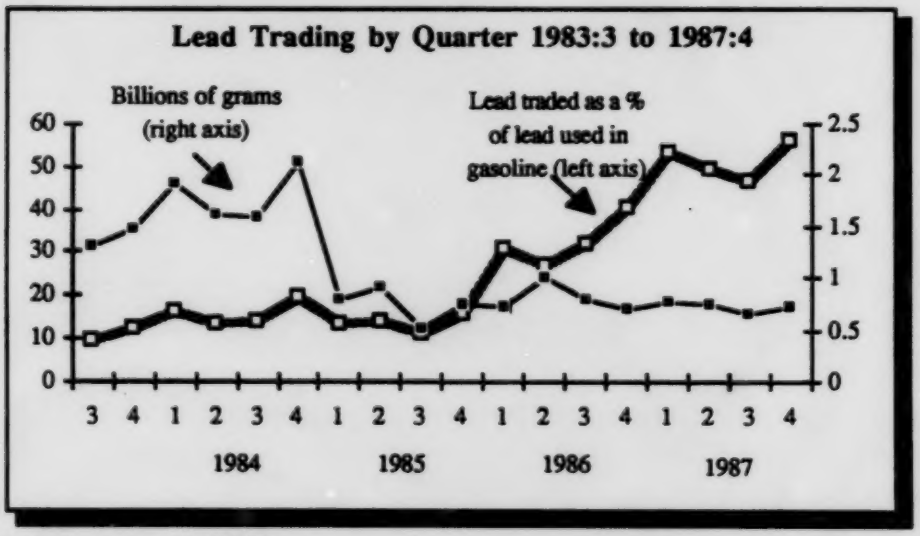
The availability of permit trading enabled refineries with lower marginal costs of reducing lead content to achieve more of the early progress towards reducing the overall level of lead emissions. Thus, the overall costs associated with the adjustments necessary during the phase-down period were reduced by the availability of trading. Similarly, banking left the total emissions over the years 1985-87 unchanged relative to a system that denied banking privileges, while offering flexibility and cost savings to refineries.

Since trading generated efficiency gains (i.e. cost-savings) relative to a system of equal standards for all refiners, the volume of trading is an important indicator of the extent to which there were in fact differences in abatement costs across refiners that created opportunities for cost-saving trades.

As shown in Figure 3.2, a brisk market developed in lead rights following their introduction late in 1983. Over 500 firms[7], more than half of those eligible, were participating in trading activity by the third quarter of 1985. The presence of a large number of participants helped to create sufficient liquidity in the lead market for trading to work well in terms of matching buyers and sellers.

In absolute volume, the greatest trading activity occurred early in the program, when some refiners were already well-positioned to greatly exceed the new standards. Not surprisingly, as the standards were tightened over 1985-87, the physical quantities traded also declined (since it became more difficult for any refiners to exceed the standard). However, as a percentage of the total lead used in domestically refined and imported gasoline, the trading activity rose through this period, peaking at nearly 60% of total lead use.

Figure 3.2



Source: Anderson et al (1989)

As shown in Figure 3.3, lead banking and subsequent withdrawal activity also covered a significant volume and share of lead used during the period.[8] Firms were able to

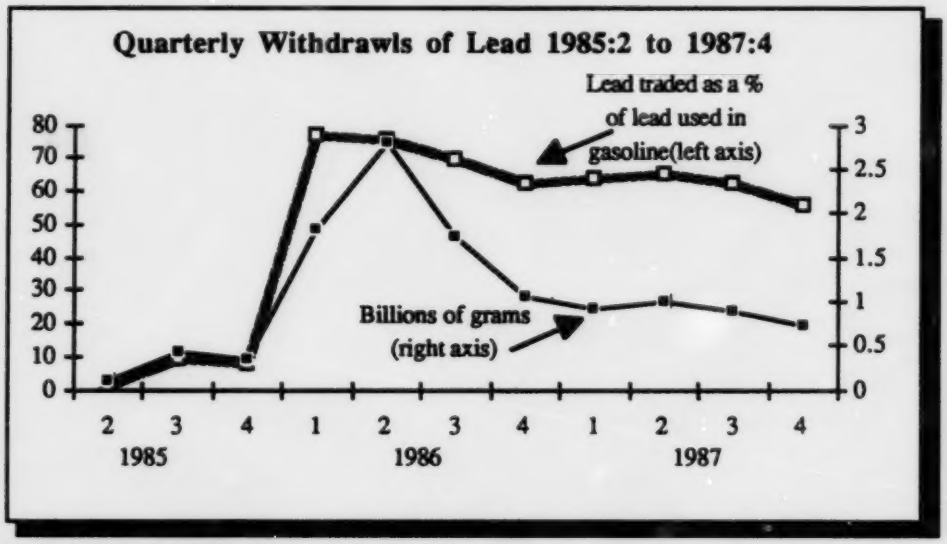
[7]Refiners, importers, and gasoline blenders.

[8]Note that the sum of the lead withdrawn from banks and the lead traded in some quarters exceeded 100% of lead used. This is because some lead was both withdrawn from banks, and then traded to another firm in the quarter, particularly in 1987 when much of the lead available to the market was from previous banking.

exceed the U.S. EPA phase-down schedule in early years, and subsequently withdrew the banked lead rights for their own use or for sale to other refiners and importers.

The U.S. EPA had initially estimated that refiners would bank about 9.1 billion grams of lead, with a resulting cost savings to refiners of $226 million. These trading opportunities were based on differences among the firms (i.e. a lack of complete homogeneity) which translated into differences in abatement costs. In fact, banking and subsequent withdrawal activity exceeded U.S. EPA expectations, with over 10 billion grams banked and withdrawn. According to Hahn and Stavins (1990), the U.S. EPA estimated that the overall trading program generated annual savings to refiners of $200 million annually.

Figure 3.3



Source: Anderson et al (1989)

iii) system adaptability

In light of the short time frame in which the program operated, it is not surprising that there was little need to make adjustments to it for changing circumstances. The only such case was the introduction of banking, which was a response to evidence that the timetable would not be met by some refiners. As discussed above, relative to a command and control policy that might have merely granted such firms more time, the banking

provisions at least generated some added abatement in 1985 in exchange for the excess emissions later.

iv) capacity to generate technological innovation; and
v) capacity to induce research and development

These issues are not relevant given the short period in which the program was in force.

vi) requirements for cost and frequency of monitoring, enforcement and administrative activities

This criterion assesses the extent to which the trading program added to the costs of monitoring environmental performance, and enforcing and administering the government's program for lead reduction. The evidence suggests that, in this case, the program was efficiently run with minimal added costs to the public sector.

The U.S. EPA already had in place a system for recording the usage of lead by refiners under its previous command and control policy. Thus, the agency had a detailed set of baseline data from which to schedule reductions in lead use, and a centralized data base in which to record lead usage and trading activity.

The operation of the trading program was relatively straightforward, according to Anderson et al (1989). In contrast to other experiences with effluent trading in the U.S., no application or approvals process was necessary for a firm to trade or bank lead rights. Simple, one-page U.S. EPA forms were used tor firms to report quantities traded, banked and withdrawn. Each firm provided a list of trades with other refiners, and a list of lead additive transfers between the firm and non-lead additive manufacturers (e.g. sales of the lead additives or gasoline incorporating the lead additives). These lists enabled the U.S. EPA to match and balance all sales and purchases of lead rights, in order to ensure that purchasers who had excess lead usage were in fact offset by sellers with reductions beyond the standard. A similar reporting system would have been required even in the absence of a trading system, in order to monitor overall lead usage.

The program had built-in enforcement incentives in terms of these reporting requirements. The buyer of the rights had the incentive to report its purchases to ensure that it would be able to justify lead content above the limit. The seller knows that the buyer will report its purchase, and therefore must report its sale accurately.

The trading market worked well, and did not involve costs associated with the setting up of lead-market intermediaries. Moore et al (1989) and other observers attribute the low-cost, high volume functioning trading market in this case to the fact that refiners and gasoline brokers were already very accustomed to inter-firm trading in feedstocks and refined products, and the fact that the permits being traded and banked carried clear rights with them. There was no perceived risk, for example, that a firm banking lead credits would later find them confiscated by the U.S. EPA.

Enforcement of the lead content itself (i.e. ensuring that each refiner accurately reported its lead content over the quarter) would have been very costly, since an individual batch sampled in a quarter would not reveal much about a refiner's overall quarterly use of lead. Enforcement depended primarily on a monitoring of the reported data, although this would have been the case in any alternative phase-out program.

vii) public, private sector and interest-group perceptions

One potential determinant of public support is the extent to which the cost savings to refiners (relative to a system of uniform restraints on lead content) are passed on to consumers in lower prices for the final product. We have not identified any *empirical* estimates of this pass-through with respect to lead trading. However, Anderson et al (1989) show that the extent to which the benefits are shared among firms and consumers is dependent on the nature of the elasticity of demand and on the way in which the industry marginal cost curve is lowered by the permits program.

If the demand for gasoline in the short-run is inelastic, Anderson et al demonstrate that, based on estimates of the impact of permits on industry marginal costs, both prices of gasoline to consumers and overall industry profits fall as a result of lead trading, relative to an equal standard for all refiners. Even if this were the case, individual firms could see an increase in profit if they were particularly active traders in the market.

In Ontario, many firms, particularly in export-based resource industries, are price takers on international markets, and thus face a perfectly elastic demand. These firms must absorb the full cost of any regulations that require expenditures to reduce emissions, and thus regulation in and of itself will reduce profits. However, a regulation with trading will then reduce profits by a lesser amount than the same regulation without trading, since trading necessarily reduces the overall cost of achieving any given total discharge reduction.

U.S. lead trading did not appear to benefit a narrow range of firm types. All types of firms Moore et al (1989) report that both small and large refiners were active traders, and small refiners were as active on the buying as on the selling side. Large refiners did more of the banking and trading overall, suggesting that they may have been greater beneficiaries of the program.

We have not identified any strong opposition to lead trading from environmental groups. The general views of U.S. environmental groups on emissions trading are discussed in our review of emissions trading under the Clean Air Act.

viii) suitability and effectiveness of public financing mechanisms

This criterion is not relevant here, in that no public funds were raised through the issue of the permits. The merits of alternative policies which involve auctioning permits are discussed in the next Chapter of this report.

ix) implications for international trade and competitiveness

In this case, both importers and domestic refiners received similar trading rights. The U.S. gasoline market is primarily served by domestic producers, and thus the direct trade and competitiveness implications were very modest. The overall savings to gasoline consumers discussed above may have provided a very slight boost to the competitiveness of some U.S. industries.

In summary, the lead trading program met the U.S. EPA's objectives for introducing flexibility and allowing for cost savings while meeting a rapid schedule for the reduction of total lead use in gasoline. The key factors contributing to this success included a full initial knowledge of lead usage prior to the program, a straightforward system of monitoring, a reasonably small number of refiners and importers being regulated who had experience in inter-firm trading, acceptance of the end target by industry, and a clearly-defined final objective. The several hundred firms involved in trading were sufficient to create a quite liquid market for lead, while not being so numerous as to create a large administrative requirement for the monitoring of trading activity.

3.3.3 The U.S. Clean Air Act 1963-90[9]

In contrast to the lead trading program, generally regarded as an unqualified success, both the use of command-and-control regulations, under the Clean Air Act (CAA) of 1963, and the emissions trading or "bubble" system, introduced in the mid-1970s, have received mixed reviews. For Ontario policy-makers, this case is instructive in terms of some of the conditions that aid or impede the effectiveness of a combined system of command-and-control and market approaches for environmental protection[10]. It also sheds light on some of the features of the pure command-and-control system that pre-dated trading and continues to underlie the emissions trading policies.

The case is also illustrative of the issues faced in the treatment of new and existing pollution sources, and in using market instruments to control for the deterioration in ambient air quality that results from the addition of new emissions sources as the economy grows, an issue to be faced by Ontario in implementing its revised air pollution control policies.

Command-and-control Under the Clean Air Act

The Clean Air Act is a traditional command-and-control piece of legislation dating from 1963. There are four types of standards under the CAA as amended in 1970 and 1977[11]:

1. National Ambient Air Quality Standards (NAAQS). These are divided into i) primary standards for health protection with federal compliance deadlines, sanctions for regional non-compliance, and no economic grounds for failure to comply; and ii) secondary standards for property, wildlife and agricultural protection, with no federal deadlines or sanctions, and economic feasibility allowed to be a limited consideration. NAAQS cover SO_2, NO_x, particulates, CO, ozone, and lead. The levels for primary standards are set at concentrations above which health effects are thought to occur.

[9]The most recent 1990 amendments to the CAA, which call for the extensive use of emissions trading to achieve acid gas reductions, are discussed in a subsequent section.

[10]To some extent, *any* trading program, including the lead program discussed above, entails the combined use of a regulation – setting the overall limit – and an economic instrument approach (trading). However, the CAA program retained much more of the usual regulatory apparatus than lead trading, since most firms were still subject to technology based standards, and trades were subject to detailed case-by-case reviews and approval processes that entailed techological evaluations.

[11]This description is based primarily on Moore et al (1979) and Rehbinder and Sprenger (1985).

2. National Emission Standards for Hazardous Pollutants, setting emissions restraints at the source level for seven substances;

3. Prevention of Significant Deterioration (PSD) rules, designed to protect areas already below the NAAQS standards from deterioration in levels of SO_2, NO_2, and TSP (particulates); and

4. New Source Performance Standards (NSPS) requiring the use by new or substantially modified sources of the best available control technology (BACT) for reducing total emissions, subject to consideration of cost, other health impacts (occupational health, solid waste and water pollution etc.) and energy use issues. By 1983, standards had been set for 70 categories of industrial sources.

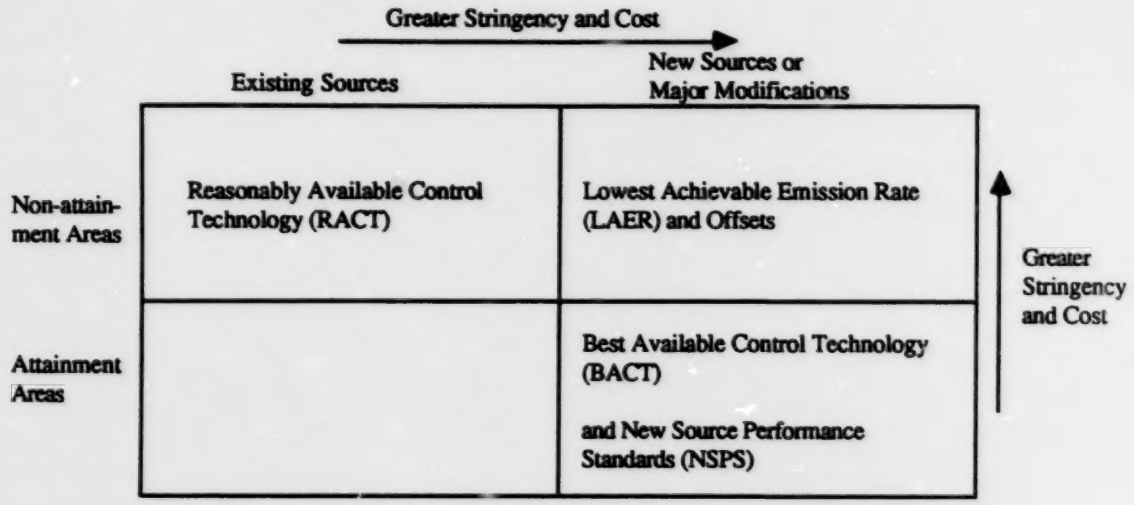
State Implementation Plans (SIPs) are submitted by each State to the U.S. EPA to provide for the attainment of NAAQS and to review and issue construction and operating permits for new major point sources.[12] In areas where ambient air quality does not meet NAAQS standards (so-called "non-attainment areas), there are two approaches to setting standards. Existing sources require the use of Reasonably Available Control Technologies (RACT) Tougher standards, requiring attainment of the Lowest Achievable Emission Rate (LAER), are imposed on new sources or major modifications to existing sources.

Note that new sources are much more stringently regulated, since existing sources in areas in compliance with NAAQS need not install control technologies, and PSD and NSPS relate only to new sources. This reflects some effort towards cost-minimization in the overall abatement strategy, since new sources typically can meet stringent standards more cost-effectively than can existing sources undertaking retrofitting. Sources of less than 100 tons of emissions also can be exempted. Figure 3.4 illustrates the various categories of regulations for stationary sources.

From 1963 to 1974, the CAA operated as a traditional command-and-control policy, with the added complexity of operating within a federal system with two levels of government involved. SIPs prepared by the states required U.S. EPA approval and had to demonstrate that they would result in attainment by the legislated deadline – 1975 or 1977 for primary standards and within a "reasonable time" for secondary standards.

[12]States lacking SIPS can be directly regulated by the EPA.

Figure 3.4
Structure of CAA Regulations for Stationary Sources


Greater Stringency and Cost
Existing Sources
New Sources or Major Modifications
Non-attainment Areas
Attainment Areas
Reasonably Available Control Technology (RACT)
Lowest Achievable Emission Rate (LAER) and Offsets
Best Available Control Technology (BACT)
and New Source Performance Standards (NSPS)
Greater Stringency and Cost

Source: Rehbinder and Sprenger (1985)

As indicated in Table 3.1, the command-and-control approach achieved significant improvements in some emissions over 1970-77 (i.e. the period after the 1970 CAA revisions and before major use of emissions trading).

Table 3.1
U.S. Air Pollution Emissions (1974 = 100)

	TSP	Sulphur oxides	NO_x	Hydrocarbons	CO
1970	145	103	92	114	108
1971	136	98	95	111	108
1972	123	101	100	112	107
1973	115	105	101	110	105
1974	100	100	100	100	100
1975	83	95	98	96	96
1976	78	98	104	100	98
1977	70	98	106	100	95

Source: U.S. EPA National Air Pollution Emission Estimates 1940-80

Despite these reductions, as shown in Table 3.2, the command-and-control policy failed to meet its targets by the initial deadlines. As a result, deadlines for compliance were extended to the end 1982 or, in the case of CO and ozone, to the end of 1987. The table shows the number of counties, out of a total of 3,140 in the U.S., that failed to attain primary standards by the 1977 deadline. Note that while many counties were in compliance, this is in part attributable to the absence of major heavy industrial sources in a large number of rural counties.

Table 3.2
U.S. "Nonattainment" Counties for Primary Standards by Contaminant

Standard	Number of Counties or County-Equivalents with Non-attainment Areas
TSP	378
SO_2	88
NO_2	11
CO	156
Ozone	486
Total	1,119

Source: Rehbinder and Sprenger (1985) from U.S. EPA data.

A number of deficiencies in the CAA and its implementation at the state level contributed to the failure to achieve targets for ambient air quality[13]:

- air quality data and modelling techniques used in SIPs failed to accurately project the changes needed at individual sources to achieve ambient air quality targets, and generally underestimated the required level of abatement;
- states were then slow to revise SIPs to reflect data and modelling advances available;
- states focussed on existing sources and failed to allow for emissions growth due to economic growth;

[13]The following is based primarily on Rehbinder and Sprenger (1985)

- SIPs failed to adequately perform the preconstruction reviews required for new and modified sources;

- polluters were able to negotiate extensions for compliance with state authorities, due to the case-by-case nature of the SIPs implementation;

Emissions trading programs were therefore introduced against the backdrop of a command-and-control program that was failing to achieve its original schedule for abatement. The introduction of flexibility through trading was essential, since the 1970 Clean Air Act would otherwise have led to widespread bans on industrial and utility construction in non-attainment areas.

The Emissions Trading Program

There are four aspects to the emissions trading program:

Offsets were introduced in 1976 in order to avoid new construction bans in the many areas that were failing to meet the 1977 NAAQS. New sources could be constructed provided they installed best available control technologies and obtained more-than-offsetting reductions from existing facilities (i.e. total emissions in the area must decline relative to the status quo before the new plant). Such opportunities for mutually-beneficial trades between a new source and an existing source were widely available due to the much more stringent standards imposed on the former in non-attainment areas. As a result, under this program the construction of new sources is the key to motivating additional abatement by existing sources. As noted, the offset ratio is typically greater than 1.0. That is, the firm reducing emissions might have to reduce by, say, 1.2 times the emissions attributable to the new source. Note also that offsets are related to ambient air quality standards achievement and introduce flexibility in the overall mix of activities designed to avoid further erosion of ambient air quality in non-attainment or PSD areas. They do not involve a relaxation of NSPS or BACT technology-related requirements, since the new source must continue to meet these.

Bubbles permit an existing, multiple source facility to meet a standard for a single pollutant in aggregate rather than at each of its stacks. The bubble can include several facilities of a given firm or, in rare cases, facilities owned by different firms. Bubbles required U.S. EPA and State approval initially, and some states have rejected the use of bubbles. Only permanent emissions reductions can be used to generate a credit (seasonal shutdowns do not qualify), reductions must be measurable and predictable based on modelling criteria satisfying the regulators. Bubbles cannot be used to avoid technology-

related requirements (NSPS and BACT) for new sources, but do allow an existing source to avoid RACT technology standards for all of its stacks in non-attainment areas.

Bubbles were initially allowed in 1975, ruled illegal by the courts[14], and then re-instated in a new form in 1979, with greater controls on the use of bubbles. According to Tether (1986), the Carter Administration sought to re-launch the bubble program with a view to demonstrating its concern for the economy, by achieving environmental goals in an economically efficient manner. A further liberalization of their use in SIPs occurred in 1982.

Netting commenced in practice in some states in 1974, although it was viewed as part of the bubble policy and not formally recognized as an official element of the trading policy until 1980. Subject to state approval, netting enables a source to undergo an expansion or modernization without meeting the stringent NSPS rules. To qualify, a firm must show that additional emissions in the expanded or modernized part of their facility, less reductions achieved in other parts of the same plant, imply "insignificant"[15] increases or decreases in total emissions from the plant as a whole, based on engineering evidence supplied by the firm to state regulators. Thus, netting goes far beyond the bubbles and offsets programs in terms of exempting firms from technology-based standards such as BACT or LAER. Netting is allowed both in non-NAASQ attainment areas, and in PSD regions.

Unlike offsets, netting and the majority of bubbles do not involve trades external to a firm or responses to a market set price or fee, and they therefore are not true economic instruments. However, they can be viewed as mimicking the effects of an open market for abatement within a firm (e.g. trades among various operating divisions of a plant), since some parts of a plant are in effect able to "purchase" rights to pollute from other parts of the same facility.

Banking was instituted as of 1979, permitting an emission source to bank emissions reductions in excess of regulatory requirements for future use or sale. Banked credits were important in facilitating bubbles and offset trading, effectively extending the

[14]The suit involved a challenge by an environmental group on the grounds that the bubbles were inconsistent with the Clean Air Act, and that the U.S. EPA was therefore failing to enforce existing environmental legislation.

[15] Less than 25-100 tons per year depending on the pollutant, or less than 0.6 tons of lead

lifespan of available credits. Individual States must establish the banking rules, subject to U.S. EPA approval. These rules sometimes allow the State to confiscate banked credits based on certain air quality occurrences, according to Anderson et al (1989), and are also subject to time limits. Formal banking rules were instituted in a number of states, while others had informal banking allowed in the practice of approving netting and offsets transactions.

These approaches, which graft some of the flexibility of market systems onto a command-and-control approach, could be implemented in a piecemeal fashion over time. Levin (1982), the Chief of the Regulatory Reform Staff in the U.S. EPA, provides a history on why they were selected over the more comprehensive marketable permits system or effluent charge methods favoured by economists:[16]

- Uncertainties surrounding the degree of abatement efforts necessary at each plant to achieve ambient air quality standards meant that state-level environmental regulations were likely to change over time. In such circumstances, most firms would prefer to install specific technologies approved by regulators rather than select the technology on their own and risk the wrath of regulators if they fail to perform. Furthermore, Congress and the U.S. EPA felt the federal government had the technological understanding to mandate the best course of action, and that states and firms could not be trusted to do so in the absence of strictly defined rules. Mandating specific technologies in most cases, but allowing for exceptions through case-by-case consideration of netting and other applications, was a compromise between a free-technology-choice system and a strict technology-forcing policy.

- The U.S. EPA system rested on pre-approved technologies (even for bubble applications). The policy-makers felt that it was easier to monitor the up-front choices of technologies for abatement than to continuously monitor emissions to assign charges or ensure the firm had sufficient emissions permits, and this offered a greater degree of assurance to regulators than a self-monitoring and reporting system;

- State agencies lacked the information necessary to set emissions fees that would be consistent with ambient air quality targets;

- State environmental agencies lacked the legislative authority to establish fees, since these would be considered taxes requiring legislative as opposed to regulatory change;

[16]These represent the U.S. EPA's views on the various alternatives that they felt were open to them, and do not necessarily correspond to our own. The purpose of this section is to review the considerations undertaken by policy makers within the U.S.

- Issuing emissions permits free based on historical emissions levels would grant a windfall to existing polluters and discourage the entry of competitors.[17] Auctioning the permits would entail huge payments by firms to continue production activities. Operating the permits markets posed administrative difficulties in screening sales to ensure ambient equivalence.

- Industry opposed having to learn to deal with a whole new regulatory system, and leading firms had found it advantageous in terms of their market shares to have a system that forced others to match their technology;

- State agencies resisted the administrative costs of a major regulatory overhaul, but could adapt to piecemeal reform;

- Environmental groups opposed wholesale reliance on market-based instruments, viewing them as "licenses to pollute under which firms could simply pay to keep emitting."

- Politically, "permits or fees threatened to expose the gross defects in air quality management" that existed at the time, including deficiencies in emissions inventories, inefficient but expedient engineering requirements that failed to adjust for differing industrial processes, and inadequate SIPs.

According to Anderson et al (1989), a more recent report by the California Air Resource Board reiterated that state's objections to the use of fees or emissions taxes, stating that fees and taxes would take control of emissions away from local districts which have the authority to approve trades under the existing policy.

Evaluation of the Trading Program

Emissions trading has failed to live up to the expectations in terms of the amount of trading generated and the economic gains achievable. However, as demonstrated in the following section, the trading program was still responsible for some impressive cost savings, and has been refined to eliminate any negative consequences for environmental quality.

i) capacity to improve environmental quality

Since the trading program was implemented as a supplement to an existing command and control policy, our analysis focusses on how the addition of trading

[17]This point by Levin is puzzling, since the offsets program does in fact grant such potential windfalls to existing pollutors relative to new entrants.

improved or hindered efforts at reducing emissions of air pollutants. On balance, while it appears that some flaws in the program may have initially resulted in a few cases where trading worsened environmental performance, these impacts were relatively minor and have been largely eliminated in more recent revisions to the program.

Emissions trading programs are thought by many observers to have had a neutral impact on environmental quality relative to a system of identical standards with no trading permitted. Since trading rules were designed to preclude trades that were environmentally damaging, Lirhoff (1986), in an analysis of the bubble policy, and Anderson et al (1989), in an overall assessment of CAA emissions trading, both reached the conclusion that trades neither harmed nor benefited the environment. Hahn and Hester (1989) report that federal and state regulators interviewed for a U.S. EPA study also believe that emissions trading has not harmed air quality.

However, others[18] have viewed the trading program as flawed in practice, and have argued that trading under the U.S. EPA and state rules, particularly in the case of the bubbles policy, resulted in a deterioration in environmental quality over what otherwise would have occurred. Although some of the criticisms levelled at the program on environmental grounds are for reasons unique to the U.S. EPA program, others entail difficulties that could arise or be avoided in any future applications of emissions trading in Ontario. We therefore consider these issues in some detail in the remainder of this section.

There are essentially five types of criticisms of the U.S. EPA trading program on environmental grounds:

First, since much of the trading was focussed on "non-attainment areas", critics argue that where a firm can exceed the existing standard, it should have been forced to do so, with no right to then sell the emissions to another firm. As Doniger (1986) argued:

> The problem is especially acute in areas that do not even have a plan adequate to meet the air quality standards in the future.... Bubbles cannot be countenanced in these areas. Every emission reduction opportunity available to them must be dedicated to meeting air quality standards. If a firm can reduce annual emissions by 100 tons, then that full amount must be used to meet standards as soon as possible [rather than allowing a firm to increase emissions elsewhere in its facility].

[18]The following section draws on criticisms of the trading by Doniger (1986) and Rehbinder and Sprenger (1984)

Levin (1982) noted that a similar view was held by many critics of the bubbles policy inside the Air Programs and Enforcement staffs of the U.S. EPA. He argues that the states would not have been able to identify these reduction possibilities in the absence of the bubbles applications, and therefore would not have mandated them under their SIPs had bubbles not existed.

This brings us to a a second criticism of emissions trading in terms of its environmental impact, which is related to the impact of trading on the setting of standards for abatement under SIPs, particularly in areas where further abatement is necessary to meet ambient air quality standards. The abatement programs are typically designed using information on feasible technological solutions provided co-operatively by industry. According to Doniger (1986), the trading policy provides an incentive for firms to refuse to identify such reduction opportunities during the standards or baseline setting process, in order to save such reduction capabilities for trades or as offsets for other parts of their facilities.

Lirhoff (1986) however, argues that trading applications are an important source of information to regulators for future adjustments to RACT requirements, and also points to a case where an application revealed an entire plant previously missing from an inventory of sources. Anderson et al (1989) offer a similar view. They suggest that this information-revealing aspect of trading applications has acted to reduce their use by firms, who may fear that revealing their ability to reduce emissions to generate emissions reductions credits for a trade may lead to tighter control requirements on other facilities they operate.

A third type of criticism levelled at the trading program on environmental-quality grounds rests in the types of activities that qualified firms for credits that could be used by other sources. Thus, rather than promoting *additional* abatement efforts that would not otherwise have taken place, it is felt that credits were granted too readily for emissions levels that would have occurred in the absence of the trading program. These credits were then used to permit higher levels of emissions from other sources, which, in a straight command-and-control program, would not have been permitted.

For example, several states made use of historical data on emissions attributed to individual sources based on imprecise modelling and measurement methods, and used past emissions as a guide for the level that the firm would have to achieve to begin to generate credits for offsetting emissions of new plants.

Thus, some environmentalists argue that firms were obtaining credits for 'phantom' reductions in emissions based on inappropriate baselines, rather than actual abatement efforts. Indeed, a study by Energy and Environmental Analysis (1986) for the U.S. EPA found that one-third of trades sampled involved what were termed "paper credits", where industries reaped credits for the difference between their emissions and allowable levels solely due to the failure in setting the permitted levels to include the true extent of previous emissions control efforts or standard industry practices.[19] In such cases, new emissions may not have been fully offset by reductions by existing sources as was intended under the offset program.

Note that this was not an issue in the case of lead trading, since credits were based entirely on gasoline production in the quarter and lead usage, rather than any historical data. Furthermore, the offsets program was particularly sensitive to this issue, since the baselines for the firms issuing the credits was in many cases intended to be the current level of emissions, as opposed to some significantly reduced value. In a program designed to reduce total emissions by, say 50%, mis-measurement of current emissions would only at worst entail missing the total reduction, as opposed to an actual increase in emissions as might have been the case with errors in the offsets program.

Other sources of credits have also been challenged by environmentalists, and they therefore argue that the use of these credits worsened the environment over what would otherwise have been the case.[20] Unanticipated shutdowns of a plant (i.e. shutdowns not built into the assumptions of a SIP) would generate credits based on their planned level of emissions. These were criticized on the grounds that other suppliers are likely to be increasing their production (and thus their emissions) to make up for the shutdown, there may have been a failure to adequately plan for the normal turnover of production capacity in the original SIP design, or in practice, the SIPs were not clear on which shutdowns were in fact anticipated as a part of the attainment program and therefore not eligible for credits. Other credits were issued based on abatement efforts by small and previously un-inventoried sources of emissions, the level of which was not part of the attainment modelling, which could then be traded to firms that were included in the SIP plan for attainment. Credits have been earned by firms taking actions (or committing to future

[19]Liroff (1986) cites two cases where it took complaints by a citizens group to disclose errors in modelling and other technical data in a trade application that was then denied by EPA.

[20]The following summary is based primarily on Rehbinder and Sprenger (1984)

actions, which may in some cases qualify them for credits) only slightly in advance of anticipated RACT proclamation or tightening, and the programs in some states allow these firms to continue to generate credits even after the RACT is in force.

Oates et al (1989) offered a general observation on this issue. They noted that any given command-and-control standard, assuming it is enforced, will lead to some degree of "overcontrol", since the discrete technology choices made by firms will often result in abatement below the actual standard. If the same standard is then used instead as a baseline for earning credits, then trading will result in higher overall emissions, since firms that would have overcontrolled would have sold their emission credits to others who will now emit more than the standard. Thus, to achieve the same level of total emissions, the baseline for earning credits would have to be set *lower* than the maximum permitted emission level under an environmentally-equivalent command-and-control program.

A fourth type of criticism involves the extent to which trades deemed to be equivalent (or an improvement in the case of offset ratios greater than one) will in fact lead to a degradation of actual environmental quality. There are several ways in which this could occur:

- a reduction in one pollutant is not equivalent to an increase in a different pollutant. Examples would include trades in suspended particulates with a different chemical composition and particle size, or trades between VOCs with differing reactivities.[21]

- equivalent trades (i.e. pound for pound) for VOCs and NO_x may worsen ambient air quality (due to different local mixing properties) where states have permitted trades between sources at a considerable distance from each other, and in the case of NO_x, may cause localized ambient air quality deterioration.

- Improper modelling (or the absence of modelling in the case of some types of trades) on such issues as stack height, velocity, topography, etc. can mean that some permitted trades involving SO_2 or TSP worsen local air quality. Inexact monitoring and modelling techniques pose problems for determining the equivalence of trades even where best techniques are applied, according to Rehbinder and Sprenger (1984).

- Trades across time (i.e. reductions in one period in exchange for higher emissions later) can worsen temporary pollution problems (episodes).

[21] *Restrictions* on trades may also have negative effects on environmental quality. For example, EPA rules bar trades between different contributors to ozone formation that would, if permitted, reduce ozone levels.

A fifth criticism relates to the specifics of the netting program, which allowed netting as long as any overall increase in emissions by the facility was "negligible". It is possible that the cumulative local impact of a series of such negligible increases would be detrimental to environmental quality.

For the most part, these criticisms would not apply to *all* emissions trading programs, but instead reflect the features of the U.S. EPA and state programs to implement trading as an adjunct to their command-and-control system. The first three criticisms in fact primarily reflect problems with the command-and-control (i.e. standard setting) aspects of the Clean Air Act, rather than trading per se. This explains why, despite some merit to these arguments, many have judged the overall impact of trading as neutral on environmental grounds.[22] It is likely that a pure command-and-control approach would not have involved any more stringent state-level standard setting during this period. As Lirhoff (1986) noted:

> [E]ven if there were considerable amounts of paper credits, it is not clear that these are a serious threat to attainment. The information contained in state implementation plans is so inexact that ... paper credits may be only a small part of the statistical "noise" in the plans.

Some other aspects of the program that were subject to abuse were subsequently corrected in the the EPA's Final Emissions Trading Policy of 1986. These set baselines for bubbles the lower of allowable or actual emissions to eliminate "paper credits" and to address, at least as of that date, the type of impacts noted by Oates et al (1989). The Final Trading Policy also required an offset ratio of 1.2 for bubbles in non-attainment areas, and provided other measures to ensure that trading did not harm the environment (e.g. restricting the distance between sources undertaking TSP, CO and SO_2 trades and tightening modelling requirements for the demonstration of equivalence). Dudek and Palmisano (1988) concluded that the Final Trading Policy has effectively closed the loopholes that existed in the early stages of the trading program.

The need for such measures underscores the importance of setting baselines (i.e. the emission levels below which credits are earned for trading) and the environmental equivalence critiques suggest the need for careful monitoring and modelling in designing trading rules.

[22]The modest share of total emissions involved in trades under the program also suggests that any advserse environmental impacts from improper trading were small.

ii) efficiency in resource allocation by polluters

This criterion assesses the extent to which trading provided savings in total abatement costs, by encouraging the greatest abatement efforts in areas where the cost per unit of abatement was the lowest. As we noted for the case of lead trading, the volume of trading is an important indicator of the extent to which trading afforded economies over a less flexible command-and-control approach. In contrast to the lead trading program, effluent trading under the Clean Air Air has not been particularly robust. Even so, the evidence[23] suggests that significant improvements in resource allocation (i.e. in overall abatement costs) were achieved relative to a straight command-and-control approach with identical overall targets.

Offsets were used by new sources to avoid construction bans in non-attainment areas by purchasing emissions credits generated by reductions from existing sources. Offsets had fairly limited use in most areas of the United States, although in total some 2,000 transactions were recorded over 1977-86. Most of these involved a firm using reductions from one of its own, existing facilities to permit the construction of a new or modified facility; very few trades took place externally (i.e. at arm's length).

The greatest transactions volume for external trades was recorded in the Los Angeles area, within the the South Coast Air Quality Management District (SCAQMD). In this area with major pollution problems, strong economic growth generated many new entrants, standards for new sources were particularly tight, and tough standards for existing sources made netting less feasible. Even so, only a modest volume of trading has taken place in SCAQMD, accounting for only a small proportion of total district emissions. As shown in Table 3.3, the wide range of market prices for each effluent suggests that trading has been too thin to bring the market to an equilibrium (i.e. a single, market-clearing price).

The low level of external trading was attributed by market participants to the lack of identifiable sellers in the market. Sellers faced uncertainties over whether or not they would be entitled to sell credits, due to the ambiguities in the baseline calculations. Transactions costs for obtaining the case-by-case approvals, and for identifying a buyer or seller in the absence of an organized market, were also significant barriers to external

[23]The most recent review of the program by Hahn and Hester (1989) provides considerable evidence on this issue, which forms the basis for much of what follows in this section.

trades.[24] Dudek and Palmisano (1988) attribute the lack of trading activity to the slow diffusion of the use of this tool among potential participants in the market, as well as to the mixed signals received from state governments on their receptivity to trades. According to Hahn and Hester (1989), "the general failure of active markets in emission credits to develop is the greatest disappointment in emissions trading." In the absence of an active market, it is likely that there were untapped opportunities for cost savings in achieving total emission reductions through trades across firms.

Table 3.3
External Offset Trades in SCAQMD 1985

	# of Trades	Total Volume Traded (tons)	% of Total Emissions	Average Price/ton ($US)	Price Range
NO_x	5	575	< 0.5	$5000	$2000 to $5500
CO	3	27	< 0.1	$3000	$1250 to $2100
SO_2	2	310	< 0.5	$3000	$2900 to $3000
TSP	3	27	< 0.1	$2000	$1250 to $2100
VOCs	42	2142	< 0.1	$2500	$850 to $3250

Source: Hahn and Hester (1989)

Even so, the fact that firms chose to pay substantial sums for offsets to locate in a non-attainment area suggests that there were significant efficiency gains in this aspect of the program, since in the absence of the program these firms would have been forced to locate in attainment areas.

[24] AERX, a Washington based firm, as well as a number of brokers in the Los Angeles area, have helped to play the market-making role in recent years in the U.S. However, brokers may charge "several thousand dollars" according to a firm contacted by Hahn and Hester (1989) for these services.

The use of **bubbles,** the most controversial element of the program on environmental grounds, has also been fairly modest in total volume. Bubbles are, with rare exceptions, "trades" that are internal to a firm. The flexibility they provide in meeting emissions standards generate savings to the firm, by enabling it to vary the abatement efforts across its facilities.

Additional cost savings were associated with the bubbles approved at the state level, which are not included in Table 3.4. In total, the U.S. EPA estimated that the 200 bubbles approved by 1985 generated some $800 million in total savings, although Hahn and Hester (1989) arrive at a slightly more modest $650 million figure. The low usage level relates to the significant regulatory hurdles that have to be cleared before a bubble can be approved, the delays and costs to the firm associated with these hurdles, and the restraints placed by the U.S. EPA on the use of bubbles.

Table 3.4
U.S. EPA Bubble Activity up to July 1986

	# Approved	Reported Cost Savings ($ U.S. millions)	Emission Change
TSP	16	$95 (six firms)	6 decreases 10 no change
SO_2	12	$10 annually (8 firms) and $17 capital (1 firm)	3 decreases 8 no change
VOCs	14	$10 (five firms)	10 decreases 7 no change

Source: Hahn and Hester (1989)

Even so, Popkin (1987) cites some impressive individual examples of efficiency gains. DuPont's major New Jersey facility targeted VOC emissions from its three largest sources (through incineration), while leaving controls unchanged at 88 stacks or vents and allowing 28 small valves to remain uncontrolled. The result was a 99% reduction in VOC emissions (vs an 85% state requirement) and a $10 million cost saving over a the same emission reduction generated equally at each one of its VOC sources. A switch to low sulphur fuel under a bubble approved for a USX steel mill generated additional reductions

in SO_2 emissions that could be used to cover emissions from other combustion sources, and saved the firm $15 million over conventional controls installed at each emission source.

Banking (generating credits for later use or sale as offsets) ultimately proved to be of minor consequence, as few states applied and received approval for banking programs from the U.S. EPA as required. Stringent restraints on the use of banked credits, and the confiscation of banked credits by states, reduced the incentives for firms to generate such credits. Informal banking on a case-by-case basis has occurred in some states, but is not well-documented.

Netting (using offsetting reductions from an existing source to enable a firm to modify an existing source without meeting stringent new source standards) has been the most frequently used method of trading, although the trades are internal to the firm. Nine hundred firms used netting in 1984, the only year for which data are available. Hahn and Hester (1989) estimate that some 8,000 firms made use of netting since 1974. Limited data are available to estimate the cost savings involved, although Hahn and Hester (1989) establish a range of $500 million to $12 billion in technology costs and $25-$300 million in the savings associated with administrative costs of permit applications that are avoided with netting.

Overall, Anderson (1989) concludes that the total savings from emissions trading have amounted to 2-4% of total U.S. air pollution control spending since 1975. This is far less than the potential savings of a fully-active trading system, which a U.S. General Accounting Office estimated could save 90% of control costs. Even so, it represents a gain that would not have been achieved in the absence of the trading program.

The administrative burdens and restraints placed on the EPA's trading policies introduced inefficiencies relative to an idealized cost-minimizing approach to pollution abatement and control. Examples of such inefficiencies cited by Anderson (1989) in California include cases where emissions credits were being sold for far less than marginal abatement costs, and thus some firms were undertaking abatement spending when purchasing credits from others would have been more efficient. In the Bay Area Air Quality District, the absence of an active offsets market led one firm to construct five small electric power plants, rather than one larger one, in order to have each plant's emissions below the level at which an offset would be required.

It should be noted that all of the cost savings estimated above are estimated relative to the costs of meeting the system of standards that existed *in the U.S.* in the absence of trading. These savings are only generated to the extent that the command-and-control aspects of the program (i.e. the baseline standards) do not already allow flexibility for differences in marginal abatement costs and appropriate technological solutions.

With the exception of LAER standards, the command-and-control aspects of the U.S. system, such as BACT, NSPS and RACT, did require the U.S. EPA and state officials to recognize cost considerations in setting source specific standards,[25] and the stricter controls on new sources reflected the savings in new design vs. retrofit of existing facilities. Even so, these command-and-control measures would not have been sufficiently adaptable to differences among firms in control costs and appropriate technologies, since, according to Rehbinder and Sprenger (1984):

- cost effectiveness is not a major objective for regulators[26];
- information available to regulators on private abatement costs is limited, costly to obtain, and tends to become dated;
- there is evidence in that the U.S. system had a "de facto requirement that new sources of air pollution install specific technology to abate their pollution". Abatement technologies installed were often those selected by the regulator, (rather than necessarily the cost-minimizing option) in order to minimize the risk to the firm in the event that the technology did not perform.

iii) system adaptability

As we noted above, the genesis of offsets, the first trading measures to be formally adopted, was the unanticipated failure of many regions to attain ambient air quality standards. Offsets were therefore introduced as a means of adjusting regulations for this new reality in order to permit economic growth, while still making progress towards air quality targets.

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[25]For example, BACT is officially defined as "an emission limitation...which the permitting authority, on a case-by-case basis, taking into account energy, environmental and economic impacts ... determines is achievable for such facility"

[26]One might qualify this conclusion somewhat. Our view is that regulatory agencies often have a mix of perspectives, with some branches having concerns over cost and economic impact issues that may not be shared by others. In the U.S., for example, the policy office within the U.S. EPA has typically been the advocate for regulatory reforms aimed at cost-minimization, with opposition coming from the Air and Water offices, in effect a battle between economists/policy analysts and engineers/scientists.

The trading system went through several revisions during its first few years of operation, culminating in the Final Emissions Trading Policy of 1986. However, the regulatory review undertaken to effect these changes was not, as Dudek and Palmisano (1988) (who are vocal supporters of the program) a short or simple process. The final notice of the changes took up 46 pages in the Federal Register, hardly characteristic of the flexible, "lean and mean" regulatory approach promised by its advocates.

In addition, individual states were refining the use of trading in their jurisdictions during the same period. The program also had a number of built-in elements of flexibility over time, such as the ability to change offset ratios in order to promote more rapid progress towards attainment.

One shortcoming in terms of adaptability over time was inherent in the banking provisions of the program. Regulators in many areas understated the extent of individual abatement measures needed to meet ambient air quality standards. They then faced the unpalatable choice of confiscating previously banked credits, which undermined the incentives for future banking, or allowing their use and thereby moving further away from air quality targets.

iv) capacity to generate technological innovation

In theory, the trading system should help to promote technological innovations, since firms finding lower cost abatement strategies are more able to put them to use (rather than meet specific technology-based standards using current technologies) and since the ability to sell credits or use them internally gives firms an incentive to find technologies that produce abatement beyond baseline standards.

There is some evidence that the CAA during the 1970s (i.e. prior to most of the trading initiatives) failed to adequately promote technological development and diffusion. Rehbinder and Sprenger (1984) cite the failure of the U.S. EPA to develop technology standards for the thousands of different pollution sources in the first 13 years of the CAA as evidence of the practical difficulties in technology-based regulatory approaches. However, this study, along with all of the other reviews of emissions trading we have reviewed, falls back on the *theoretical* advantages of trading systems, rather than any *empirical* observations on this issue.

Most of the bubbles approved by the U.S. EPA involved switching fuels or other, relatively non-innovative approaches. A bubble approved for 3M involved what Popkin (1987) judged to be "innovative low-solvent applications to reduce the plant's actual emissions (of VOCs) below the level required for conventional controls". The low level of trading under the program suggests that it has likely had only modest technological benefits.

v) capacity to induce research and development

The impact of trading on research and development is closely related to the technological progress issue discussed above. In the case of the EPA's emissions trading program, we have found no evidence on the impact of the program on R&D spending. Private sector spending on R&D related to air pollution abatement and control increased steadily over 1972-79, reaching $914 million, and then declined over 1979-82 to $713 million, according to Rehbinder and Sprenger (1984), likely due to the poorer economic climate in the latter period rather than the expansion of the trading program.

In theory, the additional flexibility introduced by the program in terms of the technological solutions to meeting control targets should increase the returns to R&D, and the ability of firms to sell "excess" reductions should give them an added incentive to search for these. This second, incentive effect is likely to have been very modest in the case of this program, since such external trades were rare except in the Los Angeles area for the reasons discussed above.

vi) requirements for cost and frequency of monitoring, enforcement and administrative activities

The complexities associated with grafting a trading system onto an existing command and control structure, the need for two levels of government involvement, and other factors, resulted in a significant administrative cost burden on both government and business. However, selected elements of the program were designed to enable firms and state governments to reduce the administrative costs that would otherwise have been faced in the command and control program.

Most of the costs to governments associated with implementing emissions trading under the CAA were those that also would have been borne in the absence of trading. These included information costs (emissions inventories, ambient monitoring, modelling, setting individual abatement standards) and administrative costs (U.S. EPA and state staff

to review permit applications, generate SIPs, company staff to deal with U.S. EPA and states).

Significant costs to the U.S. EPA (and delays for the firm involved) were faced in using federally-approved bubbles. Federal bubbles require the firm to submit a formal application, pass a Regional Office review, a review at U.S. EPA headquarters, have a notice of proposed approval posted in the Federal Register and pass a public comment period, before final approval is given by notice in the Federal Register.

Since much of the other rule-making was conducted at the state level, there were variations in the complexity of administrative procedures associated with the use of state-approved bubbles, offsets and netting. Netting involved substantially less administrative cost to firms than the alternative new source permit process. In Illinois firms using netting reported that this saving was their primary motivation for following this approach.[27]

State governments have generally argued that the EPAs trading policies imposed significant additional regulatory costs on them, over and above those faced in the absence of trading. Although data exist on air pollution monitoring, enforcement and administration costs borne by governments for air pollution control as a whole, we have not identified any overall data on the costs specifically attributable to the trading program. Rehbinder and Sprenger (1984) cite the costs associated with developing trading rules, running a credit bank (although few areas in fact operated such a bank), examining alternative emission reduction plans (engineering analysis, site visits, testing before and after), greater numbers of permits with more frequent changes, reviewing more design standards (rather than having firms use pre-approved technologies selected by the regulator), reviewing bubbles with multiple sources. Some of these burdens are being reduced with experience at the state-level and with the adoption of generic bubble rules, as might be expected as regulators and firms both "move down the learning curve" in terms of their familiarity with the program.

Some aspects of the program generate administrative savings to states. Netting reduced state level administrative burdens relative to the alternative new source reviews. Bubbles may also reduce the number of future inspections where they involve permitting uncontrolled sources in exchange for tough measures at a smaller number of sources. By

[27] Hahn and Hester (1989)

lowering costs of compliance to firms, bubbles may improve cooperation by firms and overall compliance.

As discussed above, transactions and administrative costs facing firms applying for permits to use bubbles, netting, offsets or banking are thought to be significant, and have been major barriers to more active markets.

In addition to the delays and procedures associated with federal bubbles cited above, the firm bears the cost of modelling and analysis necessary to support its application[28]. For TSP, SO_2 and CO, modelling is required for many trades among sources not in the same immediate vicinity, and a costly full dispersion modelling exercise is required for trades that fail to pass a significance test using simple mathematical methods. For open dust sources of TSP, the firm must agree to cover the cost of post-approval modelling. A single such bubble application by Armco for an iron and steel plant cost the firm several million dollars over 1977-81 with no guarantee of ultimate state approval. According to Anderson (1989), delays of more than three years are typical with bubble applications. External trades also entail the cost of searching for a trading partner (running to several thousand dollars), and modest state permit fees apply on banking transactions.

vii) public, private sector and interest-group perceptions

Support for the use of emissions trading instruments appears to have been strongest among economists in the U.S. EPA and state agencies. The EPA's Regulatory Reform Staff in the Office of Policy, Planning and Evaluation played a significant role in the evolution of bubbles and other aspects of the program. Interestingly, the primary external force promoting the use of these instruments appears to have been the economics community in academic and public-policy institutions, whose frequent claims for the superiority of market-based approaches finally filtered through to those with influence on policy development inside the U.S. EPA. The initial elements of this program were not well integrated, but were then picked up and expanded upon by a Carter Administration anxious to show its concern with the economy, and a Reagan Administration that placed a heavy emphasis on deregulation and regulatory reform.

[28]This description of requirements is drawn primarily from Rehbinder and Sprenger (1984)

As noted above, the emissions trading program was not without its opponents. Environmental groups for the most part lined up against the program, particularly prior to the later reforms to the bubbles program, and they were joined by U.S. EPA regulators in the Air Programs and Enforcement offices. Some of the reasons for their views are summarized in our discussion on environmental impacts above. Hahn and Stavins (1990) also attribute some of this opposition to the "fear of dissipation of human capital", i.e. fear of a diminished role for the visible hand of regulators and "the attorneys who have traditionally dominated the major environmental groups" as the invisible hand of the market selects the methods to achieve abatement targets. Civil suits were launched by environmental groups to attack the U.S. EPA on various aspects of the bubbles policy that they viewed as running counter to the objectives of the Clean Air Act.

More recently, support for the role of emissions trading in air pollution control in the U.S. has grown among some of the leading environmental groups. The Environmental Defence Fund played a key role in the design of the new acid gas trading system, and other groups such as the Wilderness Society, the National Wildlife Federation and the National Resource Defence Council have supported, less vocally, this extension of the trading system.

In some cases (e.g. the National Resources Defence Council), this represents a shift in their views on market-based systems,[29] and Hahn and Stavins (1990) cite a similar increase in support for trading among regulators. They attribute this trend to the rising cost of abatement (and thus the need to pay attention to cost-minimization in abatement strategies), the increasing role of Republicans and conservatives in promoting "fiscally responsible environmental protection" (rather than opposing environmental protection efforts), and the fact that environmentalists have favoured trading systems over the alternative market-mechanism, taxes (which do not explicitly set the level of abatement).

While one might assume that industries would support emissions trading systems, industries were not generally very vocal supporters of trading under the CAA. Hahn and Hester (1989) attribute this to "the fact that industry has a strong preference for greater certainty in environmental regulation." As we discuss below, some elements of American industry have also resisted trading programs for acid rain, apparently in an effort to block

[29]This group had previously been involved in a major lawsuit (National Resources Defence Council v. Gorsuch) brought against the EPA on the grounds that elements of the trading program violated the Clean Air Act.

the use of this politically attractive means to imposing much tougher legislation. For the most part, however, the general trend in industry has been consistent with that inside government and environmental groups in the U.S., toward greater support for the use of emissions trading in air pollution control policies.[30]

viii) suitability and effectiveness of public financing mechanisms

This criteria is not relevant here, in that no public funds were raised through the issue of the permits. As noted above, auctions of permits or emission charge systems were rejected by the U.S. EPA due to the high costs such methods would impose on U.S. industry.

ix) implications for international trade and competitiveness

The overall savings generated by emissions trading, while disappointing relative to pre-implementation estimates made by the U.S. EPA, still provided a boost to U.S. industries relative to a less-cost-effective and less-flexible command-and-control policy. The netting and offsets programs in particular were important as a means of enabling economic growth and permitting firms to locate in the most attractive regions of the country, while preserving environmental improvement targets. Most evaluations of the policy have suggested that the rules and administration of trading would have to be liberalized if it were to have a more significant impact on environmental control costs.

Aside from the direct cost savings, Sprenger and Rehbinder (1984) conclude that firms made substantial gains from reduced regulatory delays surrounding expansions or modernizations, and from the reduced risks to new investments associated with future inability to comply with less flexible command-and-control policies.

3.3.4 Fox River, Wisconsin, Effluent Trading Program

The use of trading programs in water pollution control has been quite limited, with the U.S. again being the country that has gone furthest in this regard. We have identified only two such applications: one on the Fox River in Wisconsin for the control of BOD, and a second in the Dillon Reservoir area in Colorado.

[30] See Hahn and Stavins (1990)

The latter program has received much praise for its potential for efficiency gains by allowing effluent trades between major point sources of phosphates and other sources. However it only created significant incentives for trading after 1990, and thus one cannot yet confirm that the program has worked as intended.

The Fox River program is thus the sole case where there may be a sufficient history to judge the success or failure of a particular application of effluent trading. However, the program was poorly designed from the outset, and thus serves primarily as a guide to the types of regulatory restraints that will hamper the operation of effluent trading. The Fox River case is also instructive on the difficulties faced in implementing a trading program among a very small number of potential traders.

History and Description of the Program[31]

Water quality in the Fox River is subject to regulation under the U.S. Water Pollution Control Act. The Act instructs the U.S. EPA to set standards for water quality, and leaves the States with the obligation to set individual permits on dischargers in order to meet these standards.

The Fox River is a small body of water into which 14 pulp and paper mills and 4 municipal wastewater treatment plants discharge. High BOD loadings, and the resulting impacts on fish stocks, lead to a need for further abatement activity by these mills and treatment plants.

Economists had suggested that significant savings could be realized if a marketable permits system, rather than fixed discharge limits, was used to control BOD effluents from these major point sources.

The program adopted by the State of Wisconsin in 1981 retained a significant command and control, technology-based, approach. Each firm was given a five-year right by the Department of Natural Resources to discharge wastes that contributed to BOD levels. No attempt was made to take differences in marginal abatement costs or economic vulnerability in assigning these rights. Rather, they were granted based on a requirement

[31]Our description draws on Hahn (1990), Moore et al (1989) and Anderson et al (1989)

for a fixed percentage reduction in discharges from historical levels, a grandfathering approach that favours existing firms over new entrants.

A firm that reduces its discharges below the assigned standard is permitted to sell this excess reduction to another point source. However, trading of these rights is permitted only after meeting very stringent circumstances:

- The plant acquiring the rights (i.e. the source adding to BOD discharges beyond the initial rights allocation) must be either: 1) a new facility; 2) an existing source undergoing an expansion that can demonstrate that after the expansion it would be unable to meet its assigned discharge limit; or 3) an existing plant that can demonstrate that it cannot meet discharge limits using best available technology.

- Trades for which the sole justification is a cost savings are not permitted. The program designers wanted each firm to achieve any technically feasible reductions in its own effluents, regardless of cost, if they were required to meet assigned discharge limits. The trading program was viewed solely as a means of making gains in environmental quality from some firms to compensate for either new entrants or cases where the reduction targets simply could not be achieved.

- The traded rights must be assigned to the purchaser by the seller for a minimum of one year and for no more than the remaining life of the right originally assigned to the seller (i.e. a maximum of five years). Rights are not guaranteed for the purchaser in subsequent assignments of discharge rights beyond the expiry of the purchased rights.

- The trade can be denied if it would result in a net increase in local concentrations of toxics (which often accompany oxygenizing substances in paper mill effluents).

- Trades must not increase BOD in either of two points on the river where BOD tends to peak. This effectively limits trades to swaps among the 6 or 7 point sources located in each of two areas along the river.

- A written permit is issued to reflect the post-trade discharge limits, following a minimum 175 day approval process.

Evaluation of the Effluent Trading Program

i) capacity to protect and improve environmental quality

The program did not significantly improve environmental quality relative to a straight command and control approach. In effect, due to a nearly complete lack of trading, water quality control on the Fox River retained all of the characteristics of a command and control policy.

Trading rules would have permitted 1:1 trades (i.e. exactly offsetting reductions and increases in effluents), and in that sense, trades would not have directly reduced discharges. However, trading could have enabled regulators to make unavoidable moves to relax standards for some plants (because they could not be met using best available technology), or permit economic growth along the river, without raising overall effluent levels to rise.

However, only one minor trade has taken place since the inception of the program. This involved a sale of a discharge permit by a paper mill that shut down its private treatment facilities, and diverted its wastewater through a municipal treatment plant, which then purchased the additional effluent rights.

There are several reasons for the absence of trading, and thus for the lack of gains in environmental quality:

- the small number of potential buyers and sellers in the market for rights, due to both the limited number of point sources in each area of the river
- most firms would not qualify as buyers under the conditions imposed. For existing facilities, the required reductions in effluents tended to be within technically feasible limits, which automatically disqualified the facility from purchasing rights, even if large cost savings from a trade were available;
- cost savings attributable to trades would, in any event, have been low relative to capital and operating costs at the facilities, according to Opschoor and Vos (1989);
- firms were reluctant to sell any excess discharge permits, since the likely purchasers were pulp and paper mills in competition with them, and since they wanted to retain the rights in the event that they wished to expand their facility;
- the interest of municipal water treatment utilities may also have been limited, since as publicly regulated utilities, they might be forced to pass on any savings generated to customers;
- purchasers were able to buy rights for at most five years, and were not guaranteed that any rights were to be assigned to them (or to their original seller) after this period. A year or two into the program, the remaining life of existing permits was quite short by most project-planning horizon standards;
- the legal status of the program was uncertain, since non-uniform standards were in violation of the federal Clean Water Act that the State of Wisconsin was charged with enforcing; and
- the administrative costs of the permit applications were viewed as high, and, after incurring these costs, the trade could be rejected on several grounds.

In part, the motivation behind the legislated limitations on trading in part rests with the limited jurisdiction of the State in this area, which might have precluded more aggressive trading schemes.[32] In addition, regulators were unwilling to depart significantly from the type of command and control practices with which they were most familiar.

ii) efficiency in resource allocation by polluters

Trading could have permitted cost savings (efficiency gains) by enabling firms with lower marginal abatement costs to reduce BOD loadings beyond the standards, and selling the equivalent effluent to firms or plants with higher abatement costs. A study prepared in advance of the program design (cited by Anderson et al (1989)) found that a full trading program with minimal restrictions would have achieved $7 million in annual abatement cost savings.

In practice, since trading for cost reasons was not permitted, and since only one trade has occurred, such savings have not materialized in this case.

iii) system adaptability

This particular program was not particularly conducive to adjustments over time, either by polluters or regulators. Trading was not permitted for periods of less than one year (and the cumbersome administrative structure for permits would have made this difficult in any event), restricting firms from using trades to accommodate temporary or seasonal changes in production volumes. Firms were not permitted to bank credits for their own subsequent use, although this might have been undesirable on environmental grounds. The one trade that did take place, however, enabled a pulp and paper mill to respond to difficulties in its own water treatment facilities, by allowing it to have the waste treated by a municipal plant.

For regulators, the lack of clear jurisdiction at the State level made it difficult to achieve adjustments to the program that might have facilitated trading. Some revisions were made in the water quality models underlying the program according to Opschoor and Vos (1989), but these were achieved only after some difficulty and delay.

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[32]The trading program was implemented after difficult negotiations between the State and the U.S. EPA, according to Opschoor and Vos (1989)

iv) capacity to generate technological innovation; and
v) capacity to induce research and development

While in theory the ability of firms to "sell" excess reductions created an incentive to apply innovative abatement methods and undertake R&D projects to identify them, in practice the Fox River program appears not to have had such incentive effects. As noted, firms had little interest in marketing credits to competitors in the paper industry. The potential cost savings were small relative to the scale of their operations, and the only trade that has taken place was not driven by the application or development of new technologies.

vi) requirements for cost of and frequency of monitoring, enforcement and administrative activities.

Regular monitoring and enforcement requirements were not altered by the existence of the trading program, since the responsibilities of the State for ensuring that firms met pre-trade permit requirements were the same as those for firms that had been issued revised permits in the wake of a trade.

Had trading been more active, the program as designed could have required a significant increase in administrative costs associated with the permit issuing process. The process required a full review of options for abatement by the purchaser of the credits, to verify the technological need for the purchase (i.e. to ensure that the firm could not meet the regular effluent standard). The limited lifespan of a permit meant that it would have to be subject to a frequent review, and the review consumed a minimum of 175 days.

vii) public, private sector and interest-group perceptions

The program appears to have met primarily with indifference by potential participants and interest groups. Paper mills were not enthusiastic supporters of the trading program, according to Hahn (1990), perhaps because they recognized its limitations.

viii) suitability and effectiveness of public financing mechanisms

The system granted the permits to existing firms, rather than auctioning them, and therefore did not serve as a public financing mechanism. Hahn (1990) attributes the favourable treatment of existing firms implicit in this grandfathering arrangement as indicative of the political appeal of such an approach, since the incumbent firms (and the

associated votes and political power) gain at the expense of potential entrants that may have to purchase permits from them.

ix) implications for international trade competitiveness

In theory, by offering the potential for lower overall abatement costs, the trading program could have served as a means of improving the competitiveness of pulp and paper mills located on the Fox River. However, as already noted, the restraints built into the program and other factors meant that these cost savings were not achieved, and thus the near absence of trading has resulted in only a minimal impact on competitiveness.

3.4 Command and Control Program Case Studies

3.4.1 Sulphur Dioxide Regulation In Ontario (Countdown Acid Rain)

Legislative Background

While provincial controls on sulphur dioxide emissions date from the 1960's and 70's, these early regulations were primarily concerned with accumulations of sulphur dioxide near the source of the pollution and local air quality. In particular, the Sudbury region was affected because of the concentration of the output from operations in that area.

The early regulations were successful in reducing ground level concentrations. Regulation 308 placed a prohibition on a source that contributed to an ambient concentration greater than 830 micrograms per cubic metre of air. Inco was ordered to build a "superstack" in 1970, and a series of control orders were issued that by 1983 reduced its emissions by more than 60% from those allowed in 1972. Hydro took steps on its own to reduce the sulphur content of its coal, while Falconbridge had control orders postponed due to failures in the control methods installed.

Because of the local nature of regulation during this period, both in terms of the standards set and the enforcement of those standards, and the considerable changes in environmental policy and management since then, the history of early sulphur dioxide controls may not have many lessons for current policy decisions. Consequently, this case study focuses on the more recent federal/provincial initiative to control acid precipitation in Canada.

In 1980, the federal government and the seven eastern provinces began the process of establishing reduction standards for sulphur dioxide in Canada using both scientific and economic rationale. The total level of reduction chosen was based on a calculation that the environment could withstand deposition rates equal to approximately half of those in 1980. Each province was asked to become responsible for achieving a share of the total required reduction tonnage and to reduce its emissions based upon total emissions in the province in 1980 (allowance was made for variances in annual production), with some consideration for the ability of the province to make reductions (for example, Nova Scotia's almost total reliance on coal fired generating stations was taken into account) and the impact on the province's economy. The model for reduction was based upon Ontario's model. The emission goals were set in 1984, and companies were given 10 years to comply. Countdown Acid Rain was announced at the end of 1985.

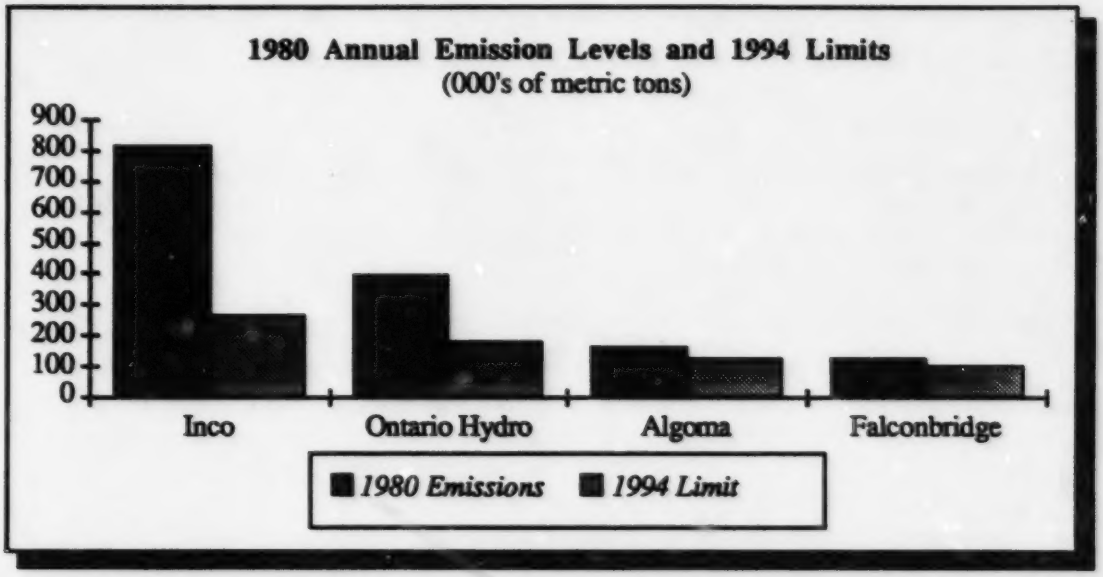
In Ontario, four companies (Inco, Ontario Hydro, Algoma, and Falconbridge) are expected to make all of the cuts required to meet the province's 1994 quota. Together these companies account for some 80% of sulphur dioxide emissions in the province.

In establishing emission standards for these companies, the province took a number of factors into consideration, including both past history and economics. For example, Falconbridge has already invested heavily in a variety of mechanisms to control sulphur dioxide emissions. As a result, Falconbridge's current emissions of sulphur dioxide per tonne of mineral produced are much lower than those for the province's other major nickel producer, Inco. The standards for 1994 set limits for both companies such that the amount of sulphur dioxide emitted per tonne of metal produced will be approximately the same for both companies when the new limits are met.

In setting the limits for all four companies, the Ontario Ministry of the Environment used a model which took into account the cost per tonne to reduce emissions. The Ministry was aware that Ontario Hydro's cost of reducing emissions would be significantly higher than that for the other companies which would have to reduce emissions. In addition, it recognized that Inco and Falconbridge had the ability to achieve a return on their investments through improved productivity, while Hydro's expected expenditures in flue gas desulphurization equipment provided no financial return.

Figure 3.5 illustrates 1980 emission levels and the 1994 targets set for each company.

Figure 3.5



Source: Ontario Ministry of the Environment Acid Precipitation Office

The chart shows that, of the four companies, Inco will be required to make the largest reduction in emissions. The limit for Falconbridge reflects the investment the company made to reduce emissions prior to 1980 and the fact that the amount of SO_2 emitted per tonne of mineral production by the company was significantly lower than that of Inco.

Evaluation of the Countdown Acid Rain Program

As in the other cases considered in this Chapter, we evaluate the effectiveness of a given environmental policy mechanism against the alternative types of approaches that might have been adopted. In this case, where possible, we explore the extent to which the command and control approach has offered benefits or has shown deficiencies relative to a system of marketable permits for SO_2 emissions, the most frequently suggested economic instrument approach for this problem.

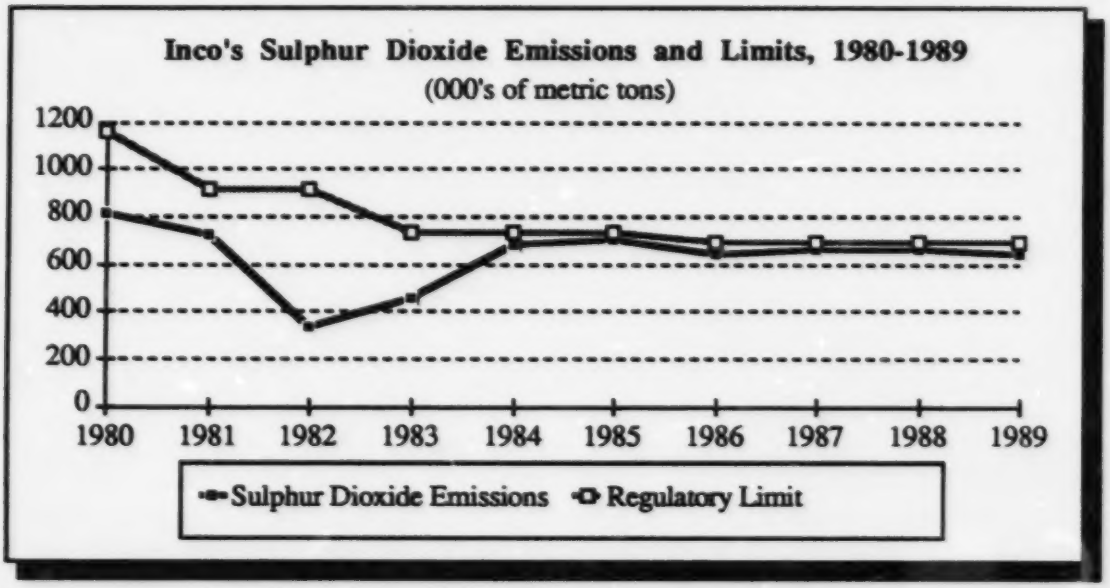
i) capacity to protect and improve environmental quality

The efficacy of command and control legislation with respect to abatement of acid gas emissions throughout the 1980's has to be examined with the knowledge that, from the

Government's perspective, the important reductions in sulphur dioxide emissions will be made in 1994. As a result, Inco, Falconbridge and Algoma were not asked to make significant reductions in the 1980's, although some cuts were made. Ontario Hydro was given reduction targets prior to 1994.

Figure 3.6 shows historic levels of emissions for Inco and the targets set by the Ontario Ministry of Environment under various Control Orders for the years 1980-89.

Figure 3.6

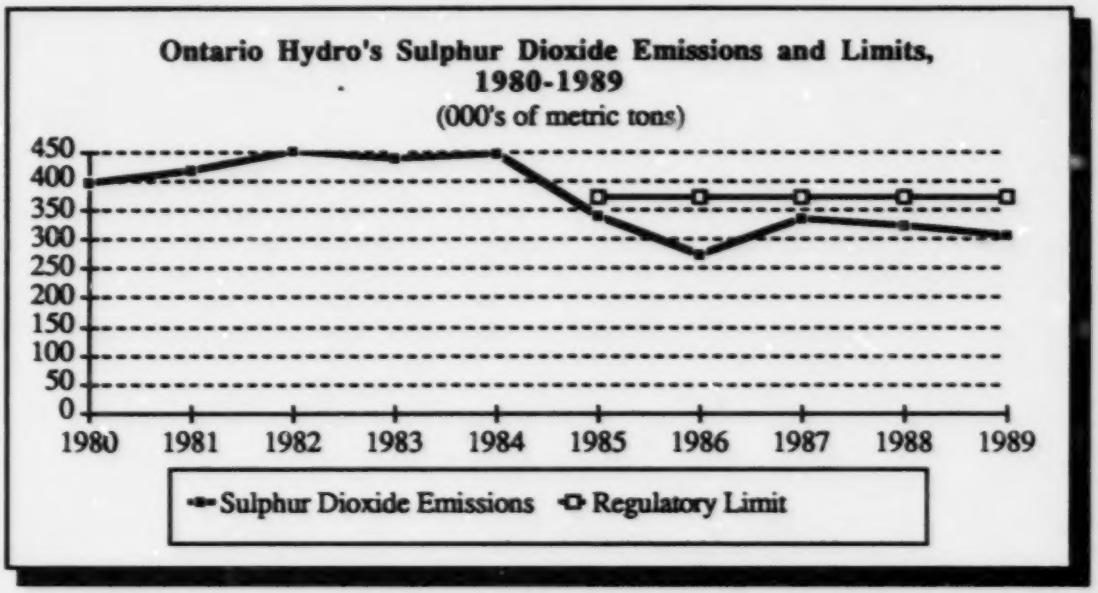


Source: Ontario Ministry of Environment Acid Precipitation Office.

Inco's SO_2 emissions fell sharply in 1982-83 due to lower mineral output. Except for that period, both production and SO_2 emissions have remained fairly constant during the last ten years. While Inco has managed to meet the targets set by the Ministry throughout the decade, these targets did not require a substantial investment by the company. Although the target set by the Ministry of Environment declined substantially from 1980 to 1984, it did so from a level which was well above Inco's emissions at that time. Beyond 1984, the target has remained at or near the same level.

Ontario Hydro's emissions and targets for the same period are illustrated in Figure 3.7.

Figure 3.7



Source: Ontario Hydro and Ontario Ministry of Environment Acid Precipitation Office

There were no numerical targets set for Ontario Hydro prior to 1985.[33] However, the target for that year required a substantial reduction in SO_2 emissions from the previous year as part of the new government's efforts to control emissions from all sources. These limits were based on earlier targets set by Ontario Hydro in consultation with the government. Ontario Hydro met the new limits primarily by shifting to low sulphur coal (1.6% sulphur content versus 2.5% for the coal previously used).

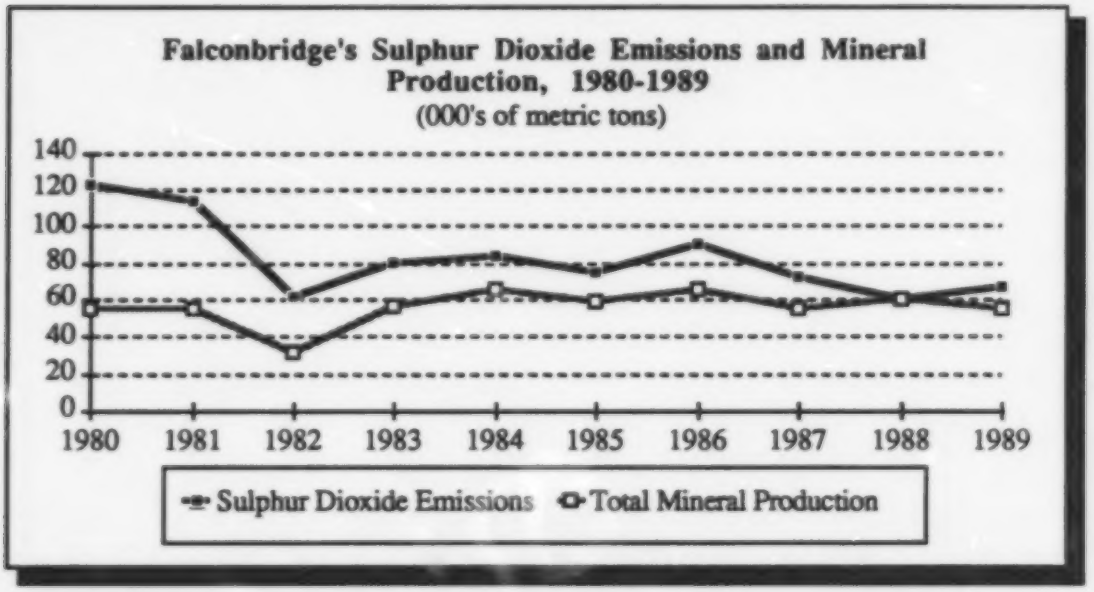
Falconbridge's emissions of sulphur dioxide per tonne of output are much lower than those of Inco. The lower emission levels are the result of new process technology installed by the company during the 1970-79 period. In particular, the company installed a new fluid-bed roasting system and electric furnaces, as well as a 1,100 tonnes per day sulphuric acid plant, all of which contributed to significant reductions in SO_2 emissions. Although there were other non-environmental reasons for choosing to install a new roasting technology (the company's technology in the 1970's was considered by management to be

[33]because Hydro's SO_2 emissions are less concentrated than those of Inco or Falconbridge, they were not considered a threat to local air quality and, consequently, emissions reductions were not required until government decided to implement its 'Countdown Acid Rain' program

inefficient), environmental benefits were an important factor in making the investment. In the 1970's, the provincial government had ordered Falconbridge to take steps to improve local air quality. While Inco was able to meet this requirement by building a large stack which allowed the SO_2 to disperse further afield, Falconbridge was unable to do so because of the presence of a local air field. As a result, the company took appropriate steps to reduce its SO_2 emissions.

Figure 3.8 shows SO_2 emissions from Falconbridge's operations in Ontario from 1982 to 1989 compared with its production of minerals. The emissions limit for Falconbridge for this period was 154,395 tonnes per year, and the company has been well under that number throughout the decade. Its 1994 emissions target is 100,000 tonnes per year.

Figure 3.8



Source: Ontario Ministry of Environment Acid Precipitation Office and Falconbridge Annual Reports

Like Falconbridge, Algoma's SO_2 emissions are already below the 1994 limits set for the company. Algoma's emissions declined substantially in the 1980's due to a reduction in output. It is unlikely that the company would have to invest in capital equipment to meet the future targets unless its production were to increase substantially. This possibility is remote given the current financial situation of the company.

It is difficult to measure the effectiveness of command and control during the 1980's because of the way in which limits were set. Clearly, the 1994 target levels are considered to be more important than the limits set during the 1980's, and the interim levels which companies are meeting now have not required any significant effort on the part of any of the large emitters. Therefore, while command and control has met the Ministry's objectives for the decade, the real test of the system will come in meeting the 1994 targets. Based upon our discussions with industry participants, we believe that each of the four companies targeted for reductions will be able to meet these limits and, therefore, command and control legislation should adequately meet the province's environmental objectives.

ii) efficiency in resource allocation

The 1994 limits, which were agreed to by both industry and government, were based upon several factors including the ability of the company to meet regulations. The limits recognize that Ontario Hydro, for example, will have more difficulty in cutting back on emissions than will Inco. As a result, Ontario Hydro will have to reduce its emissions by some 56% of 1980 levels by 1994, compared with almost 67% for Inco. Neither Falconbridge nor Algoma Steel will need to reduce emissions below current levels to meet the 1994 limits.

The approach for each firm was also more flexible than the regulatory policies that prevailed under the Clean Air Act in the U.S. prior to the introduction of emissions trading. Dewees (1990b) notes that Ontario's policies restricted emissions at the corporate, rather than the individual facility level, effectively incorporating the "bubble" concept.

Even with this flexibility, there are still significant differences between companies in the cost of meeting the new standards. In particular, Ontario Hydro's costs are significantly higher per tonne of reduction of SO_2 than for the other companies. These costs are described in detail below. As a result of these differences, there are untapped opportunities for reducing overall SO_2 emissions in a more cost effective manner through greater reductions by these other companies in exchange for a reduced level of abatement by Hydro.

Inco will have invested some $500 million[34] in the development and installation of new milling and smelting technology to reduce SO_2 emissions by some 400,000 tonnes per year (a capital cost of $1,250 per tonne per year). At the same time, Inco's investment will significantly reduce the company's energy costs and, therefore, result in a positive return on investment (see *Implications for International Trade Competitiveness*). However, the rate of return on these investments, although positive, would not have been sufficient to induce the company to make the investment in the absence of environmental regulations and objectives.

According to information provided to us by Ontario Hydro, the flue gas desulphurization units which the company proposes to introduce at the Lambton Generating Station will cost about $595 million (1990 present value) to install and will reduce SO_2 from the current levels of 89,000 tonnes per year to approximately 20,000 tonnes per year. The capital cost per tonne per year of SO_2 eliminated is some $8,623. The present value of the operating cost for the flue gas desulphurization units based on a 16 year life is $159 million or equal to $2,304 per tonne of SO_2 eliminated. These operating costs will be partially offset by purchasing less expensive coal with a higher sulphur content.

Falconbridge's total mineral production capacity is approximately 80,000 tonnes per year (consisting of 40,000 tonnes of nickel, with about an equal amount of copper), while production during this period was about 60,000 tonnes per year. The company estimates that, at full production, SO_2 emissions would be about 104,000 tonnes per year compared with a 1994 limit of 100,000 tonnes per year. Consequently, if the company were to decide to make use of its full capacity to produce nickel, the company would have to reduce its SO_2 emissions per tonne of nickel produced.

Of more importance, according to Falconbridge, SO_2 emissions could be reduced further by the installation of process equipment similar to that being introduced by Inco. The capital cost of installation would be offset by energy savings and result in a cost of SO_2 elimination lower than that of Ontario Hydro.

[34]Interview with C. Ferguson, Director of Environmental Affairs - Inco, and Annual Information Form.

Algoma should not have to undertake any additional expense to meet the 1994 limits.

Thus, based on the review above, there are substantial differences in the costs per unit of abatement that will be incurred by the various firms involved in meeting the current regulatory targets. It therefore follows that, assuming that regulators are only interested in total Ontario SO_2 emissions,[35] the current system does not achieve the target level in a manner than minimizes total abatement costs.

A system of marketable permits would enable the participants to achieve the same overall reduction at a lower total cost. While there may be too few players in this potential market to achieve an effective level of trading, even only limited activity trading could generate significant cost savings. It seems that Falconbridge could reduce its SO_2 emissions further at less cost than that incurred by Ontario Hydro to make its initial reductions, and thus a permit system would see the former selling emissions rights to the latter. While we have no data on Inco's costs for reducing emissions below the 1994 limits, it is likely, given the information which we have on the cost of meeting the 1994 targets, that these would still be lower than Ontario Hydro's.

These trades, however, would only be possible if emissions were judged to be of equal environmental damage from the various sources involved. This might not be the case when judged from a particular geographic location. One potential difficulty in this regard is the fact that Hydro's emissions have a greater potential for cross-border impacts on the U.S. than those of Inco, while the latter may have more of an impact on Quebec. Other jurisdictions might therefore voice concerns with regard to certain trading possibilities. This could be handled by imposing some restrictions on trade made at a distance (e.g. setting a maxmium quantity for such trades).

iii) system adaptability

The long time frames required for the major sulphur dioxide sources to respond to command and control limits would make it difficult to adjust these limits without a further

[35] As we discuss in Chapter 5, this might not in fact be the case. For example, regulators (and perhaps U.S. officials concerned with transboundary pollution) might be concerned over the regional impacts of allowing trades between, say, Inco and Hydro, if the result was an increase in emissions in Southern Ontario and a decrease further north.

lengthy adjustment period. Thus, if it were found that a tougher standard was required, some firms would face high costs in adjusting to a new approach having made fixed investments to meet present standards.

Of the alternative approaches, marketable permits would also appear to share the same lack of flexibility over time, since an adjustment in permit values would be, in effect, an expropriation of an asset purchased by firms or Hydro from other sources, and would impose the same adjustment costs. Pollution tax rates might be adjusted more readily than command and control or marketable permits regulations, since polluters would be free to determine the degree of adjustment in terms of the total quantity of emissions. The tax revenues raised could be used to subsidize some of the adjustment costs involved in meeting a revised emissions target.

iv) capacity to generate technological innovation

Inco has responded to the 1994 limits by developing new milling and refining technologies. According to data provided by Inco, these technologies will allow the company to meet the 1994 limits at a much lower cost compared with abatement and control technologies such as flue gas desulphurization. An important element in its ability to respond was the time period between announcement of the targets and the target date itself (a period of 10 years) which allowed the company to develop a much more economical solution than was available to it in the short term. The company recognizes that a shorter time period would have forced it to use existing technology which, in its view, would have been uneconomical. If, for example, the company were to use flue gas desulphurization equipment such as Ontario Hydro will install, the company would have a large capital investment with no offsetting operating cost savings.

Inco was unable to provide us with estimates of the cost of meeting additional reductions in SO_2 beyond 1994. However, the company indicated that if future reductions were necessary these would be made by changing the process, rather than installing abatement and control technology such as that which Hydro is using. Inco also expects that these changes would be more expensive than those currently being made, although the exact cost per tonne of SO_2 removed is unknown.

Hydro has also adjusted in the short term by using low-sulphur coal. In the longer term, however, the company is being forced to implement a very expensive solution. It might be argued in this instance that command and control has not allowed Hydro to

accommodate change and that a longer time period would have allowed Hydro to develop new and more economical solutions, although there is no guarantee that the company would have done so.

A marketable permits approach, by encouraging a greater share of abatement at Inco and Falconbridge relative to Hydro, could have increased the use of the more innovative and cost effective approaches available to the metals companies.

v) capacity to induce research and development

The R&D response to command and control legislation has been mixed. While Ontario Hydro has relied primarily upon existing technology (flue gas desulphurization). Ontario Hydro has obtained the rights to a new dual-alkali process which will be used at Nanticoke. This technology provides more flexibility for Hydro, although it will not significantly alter the cost of reducing emissions. Both Inco and Falconbridge have taken a different approach. Falconbridge, in the late 1970's, adopted new process technology which led to a significant reduction in SO_2 emissions. Inco has taken a similar path in developing its own process technology .

While in theory economic instrument approaches provide important incentives for research into cost-effective abatement technologies, such incentives are not necessarily lacking in command and control programs, particularly where the latter are primarily based on meeting abatement targets rather than on forcing the use of specific control technologies. A key factor in the creation of such incentives lies in creating and communicating credible long-term targets for abatement.

Command and control legislation for acid rain reduction has led to research and development of new technologies at both Inco and Falconbridge. A key feature of the capacity to induce research and development is the time interval between introduction of the legislation and the target date for compliance.

Inco argues that the ten-year period between the original issue of the control order and the target date of 1994 was sufficient time to meet its target. Inco has developed new milling and smelting technologies which were the result of the need to reach certain limits on SO_2 emissions by 1994.

If Inco had been forced to make its reductions prior to 1994, the company would have had to use existing technology that probably would not have had any economic

benefits for their smelting process. Once installed, there would be less incentive, and less capital available, to undertake the research and development and installation of an alternative system. At the same time, it must be recognized that emissions from Inco will not decline during this ten year period, resulting in more environmental damage than would have been realized under a system using sliding scale limits, i.e. step-wise reductions each year.

Falconbridge's technological change is another good example of research and development incentives created under a long-term command and control approach. The company's Smelter Environmental Improvement Project spanned 9 years of research and development and pilot projects. The total cost of the project was $15 million in R&D and $83 million in capital. Based on information supplied to us by the company, the cost of the project in 1990 dollars would be in the range of $240 million.

Hydro agreed that a minimum of ten years is required to bring a new technology on line, partly because of the three to five years required to gain approval from the Ministry before the introduction of new technologies. However, despite having the same amount of time as Inco and being faced with very high capital costs, Hydro has chosen not to develop new technology in this area.

vi) requirements for, cost of, and frequency of monitoring, enforcement, and administrative activities

The burden of monitoring acid gas emissions has traditionally fallen on polluters. Both Ontario Hydro and Inco use mass balance methods to determine the amount of SO_2 emitted into the atmosphere. These estimates are based on production levels using algorithms developed from past experience and testing and, as such, are considered to be reasonably accurate. Inco does have a continuous monitoring system in its stack at Sudbury, but claims that the system is not sufficiently accurate over the short term to be a reliable measurement of emissions. Hydro will have continuous monitoring systems on its flue gas desulphurization units installed at Lambton.

At present, the Ministry of the Environment calibrates the monitoring system within the stack at Inco's stack every quarter, but otherwise does not undertake any other monitoring procedures. Continuous monitoring systems at Hydro's Lambton plant would presumably require similar calibration.

There is no evidence to suggest that monitoring costs for a command and control system would differ from one using marketable permits or emission charges. In any of these cases, companies would have to monitor their emissions and provide information to the Ministry. Presumably in each case the Ministry would audit the amount produced so as to know whether companies are working within their allowable limits.

vii) public, private sector and interest group perception

Opinions on the success of command and control were mixed. Interest groups criticized command and control as ineffective, although most perceived that the reason for the ineffectiveness was not the legislation, but the unwillingness of the government to adopt tougher standards or to enforce regulations.

In the private sector, Inco reported that command and control legislation has worked well. The company believes that, given enough time to develop economic solutions to environmental problems, command and control can be effective.

It appears that economic instrument approaches would have no less support from some groups, and might be better received by industry. We found few groups or individuals who were adamantly opposed to the concept of tradeable permits with respect to sulphur dioxide emissions. Ontario Hydro is clearly in favour of the option because it has the most to gain from such a system. While Inco supports the concept, it believes that tradeable permits involving itself and Ontario Hydro would meet with resistance from interest groups and the general public if the two largest emitters were not forced to make cuts in their emissions to some maximum level.

Of three environmental groups interviewed, none were opposed to tradeable permits in theory. However, of the three, one argued that Ontario Hydro should not be allowed to buy permits and should instead be forced to do whatever is possible to limit emissions because Hydro has the ability to pass along all of its costs in the form of higher electricity bills. However, other companies could be allowed to trade permits if such a system were adopted. One organization indicated that it would want to be able to participate in such a system by purchasing permits from companies and thereby reducing the total amount emitted into the environment.

The use of environmental taxes to reduce sulphur dioxide emissions was not well received by interest groups or the private sector, largely because most believe that the

money would not be used for environmental purposes but would, instead, be put toward general funding purposes. There is also a recognition that rates would have to be quite high to encourage abatement by industry, and that such high rates might be successfully opposed by industry groups.

viii) suitability and effectiveness as public financing mechanisms

No revenues were raised through this command and control policy.

ix) implications for international trade competitiveness

For Algoma, the cost of meeting the 1994 limits should not impact on the company's competitiveness because the company is already under the limits set by the Ministry and further capital spending is likely unnecessary. Falconbridge anticipates capital spending of some $38 million between 1989 and 1993 to ensure that the company would be within the 1994 limits when operating at full capacity. This amount of spending should not have a significant impact on Falconbridge's competitiveness.

Inco's capital costs will be more than offset by a reduction in operating costs as a result of the new technology which is being implemented to reduce sulphur dioxide emissions. The new process will eliminate purchases of 2 billion cubic feet of natural gas per year, and reduce overall energy consumption per pound of nickel and copper produced from 15,400 BTU's in 1980 to 4,300 BTU's in 1994. Inco's calculated return on investment for the first stage of the project is 22% and 7-8% for the second stage.

Although Ontario Hydro does not compete with foreign competitors, an increase in its costs leads directly to a rate increase which can, arguably, affect the province's competitiveness as a whole. We are not aware of any forecasts of rate increases based upon future environmental expenditures. Our calculations indicate that the impact on the cost of electricity to customers would not be significant. Ontario Hydro sells about 135 billion kwh per year. According to Ontario Hydro, the cost of capital for the flue gas desulphurization units at the Lambton generating station (including working capital) is equal to some $83 million (assuming a 11% cost of capital). This is equivalent to a cost of about .06 cents ($0.0006) per kwh.

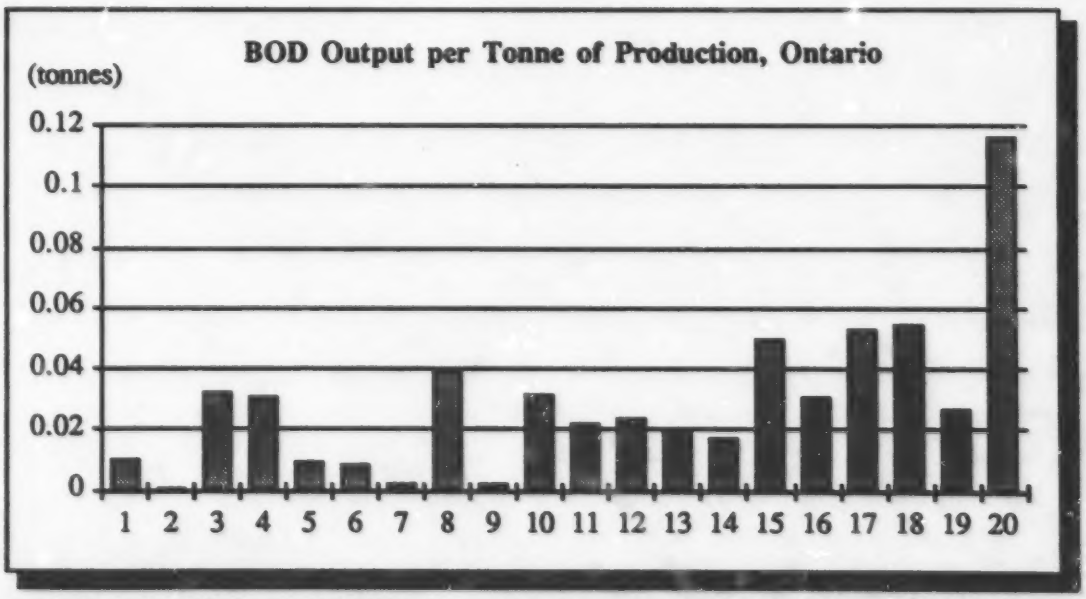
3.4.2 Biochemical Oxygen Demand (BOD) in the Pulp and Paper Industry

Biochemical Oxygen Demand (BOD) is a measure of the tendency of an effluent to consume dissolved oxygen from a receiving water by natural biochemical degradation. Too much BOD in the water system can be acutely lethal to fish and other living creatures that depend upon oxygen in the water for survival.

According to Bonsor (1990), the pulp and paper industry is the largest single industrial discharger of pollutants into Canada's waterways. Its emissions include traditional pollutants (BOD and TSS) as well as toxic organochlorines produced by mills using chlorine in the bleaching process. This case study focussed solely on the control of BOD discharges.

Chemicals commonly used in the pulp and paper making process have a significant effect on BOD levels. Chemical pulping systems, such as kraft and sulphite pulping, typically produce more BOD than mechanical pulping systems. Both processes are used extensively in Ontario and some mills use both mechanical and chemical pulping processes.

Figure 3.9



Source: Ontario Ministry of the Environment, Report on the 1988 Industrial Direct Discharges in Ontario, December 1989; The Development Document for the Effluent Monitoring Regulation for the Pulp and Paper Sector.

Figure 3.9 illustrates the BOD output per tonne of production for 20 pulp and paper mills in Ontario. The mills have been ordered by type, so that mills using the same process are grouped together. Kraft mills are numbers 6 through 14; sulphite mills (or those using some sulphite process) are numbers 16 through 20; mill 15 uses a combination of pulping methods. It is evident that there is a great deal of disparity between the level of production and BOD emissions, even within those mills using the same process, although on average sulphite mills produce higher levels of BOD per tonne of product. This disparity between mills of the same type might be attributed to several factors such as differences in the pulping or paper making process and the product being made, or the degree to which secondary water treatment is used.

History of the Legislation

In the 1960's, the Ontario Water Resources Commission undertook waste surveys of all pulp and paper mills discharging wastewaters directly into the environment. This survey discovered excessively high levels of daily BOD discharges. As a result, the government issued a series of control orders placed on individual plants. Target levels were based on the process used in the plant, production levels, and the economic feasibility of making reductions. These targets were not well received by industry and implementation was difficult. Some progress was made, however, and by the early 197\'s, some of the worst offenders had either shut down for non-environmental reasons or had replaced their process with cleaner technology.

Ontario's MISA program will address levels of BOD in wastewater effluent from pulp and paper mills. The MISA program was started in the mid-80's, and emission levels are expected to be established within the next two years. At this point in time, however, the Ministry has not determined whether a universal standard will be set for all mills, or whether each mill will be given an individual standard. If the latter is the case, we would assume that the standards would take into account both specific environmental concerns as well as economics,[36] much in the same way as control orders have in the past. If so, there would be less opportunity for the effective use of economic options.

[36]The MISA regulations stipulate that Best Available Technology - Economically Achievable will be the basis for setting emission limits.

The federal government passed regulations governing pulp and paper effluents in November, 1971. Three levels of compliance were established: one for new mills, one for old mills, and a third for old mills which undergo modernization. The requirements adopted by Environment Canada were based on "best practicable technology".

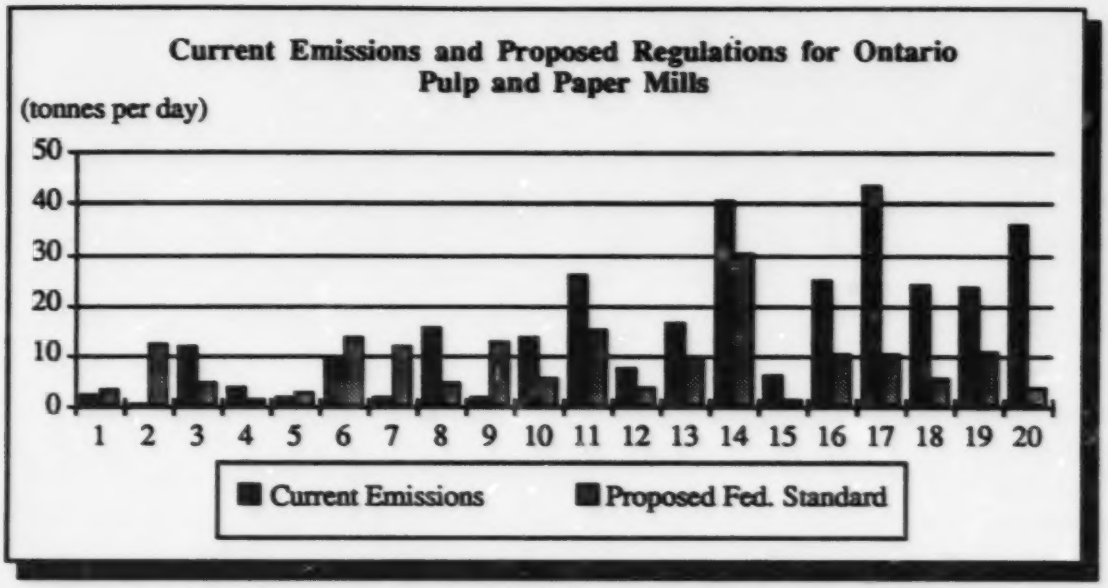
In 1979, the Ontario and Federal governments supported a financial initiatives program to help pulp and paper mills in the province upgrade and modernize their technology. Many mills participated in the program, and there was some reduction of wastewater emissions as a result, although the exact impact is not known. Environment Canada estimates that the program was probably responsible for 30% to 40% of the reduction in effluent for those mills which participated.

The federal government is currently considering a new standard for BOD for all pulp and paper mills in Canada. This law would limit the monthly total of BOD from any mill the following formula:

Maximum monthly discharge = 5 kg. x the number of days in the month x 1.5 x the reference production rate of the mill.

Alternatively, the daily maximum limit per mill is equal to 5 kilograms times 2.5 times the reference production rate. Figure 3.10 compares the 1988 average daily emissions from 20 pulp and paper mills in Ontario, as measured by the Ministry of the Environment, with a calculated proposed rate based on the daily formula described above.

Figure 3.10


Current Emissions and Proposed Regulations for Ontario Pulp and Paper Mills
(tonnes per day)
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Current Emissions
Proposed Fed. Standard

Source: Ontario Ministry of the Environment, Environment Canada.

The chart shows that while many mills are below the proposed standard, there are equally as many above the standard. The proposed legislation does provide for additional deposits of BOD for dissolving grade sulphite mills as well as for those mills where the water taken in by the mill contains BOD. In the chart, mills 16 through 20 are sulphite mills.

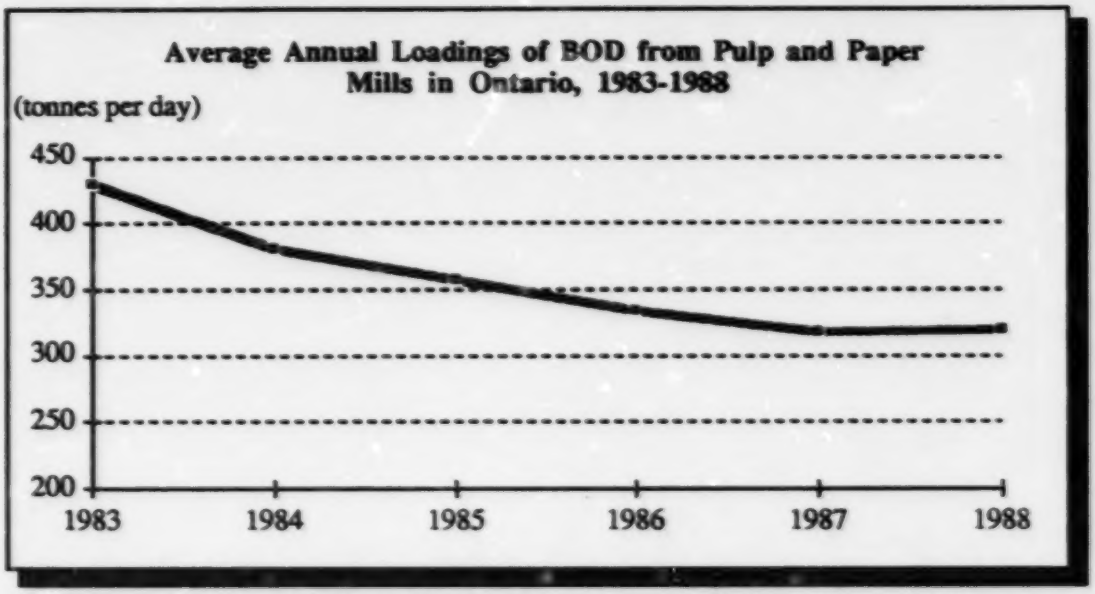
Performance of the Legislation

i) capacity to protect and improve environmental quality

While BOD levels in Ontario have declined steadily during the past decade, some of this success has to be attributed to the mill modernization program initiated in 1979 which has led to installations of environmental equipment in several mills. However, it is fair to say that command and control has had individual successes, i.e. some mills have significantly reduced BOD levels while others have made little progress in that direction. According to Bonsor (1990), Ontario mills range from among the cleanest in the world to some with very high discharge rates.

Figure 3.11 shows total daily BOD loadings from pulp and paper mills in Ontario for the period 1983 to 1988.

Figure 3.11



Source: Reports on Industrial Direct Discharges in Ontario, 1984-1989, Ontario Ministry of the Environment

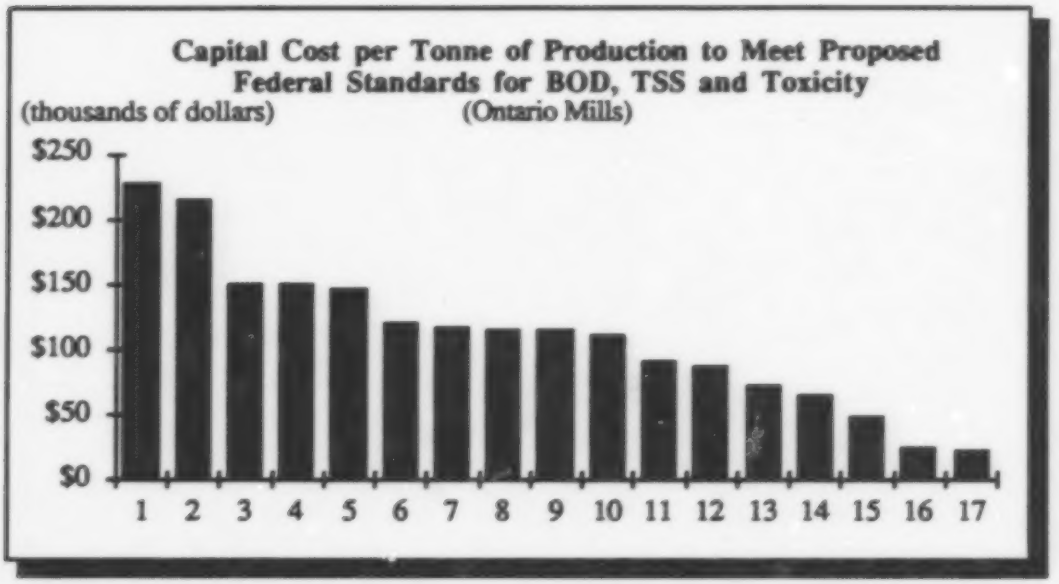
To our knowledge, no targets were ever set for BOD levels from the pulp and paper industry in the province, although the Ontario Water Resources Commission in its 1970 report recommended reductions in BOD of better than 70% in five years. According to Environment Canada data, daily BOD loadings in Ontario from pulp and paper mills declined from a high of 600 tons per day in 1978 to 375 tons per day by 1985, or a reduction in BOD loadings of some 38%. These reductions are attributable to both the mill modernization program and federal and provincial legislation setting targets for reductions.

Several studies cited by Bonsor (1990) have been highly critical of the environmental performance of federal and provincial command and control policies in this area. Bonsor argues that the high costs of compliance, the case-by-case control order approach, and government concerns over economic impacts, gave industry the incentives and the ability to resist tough measures.

ii) efficiency in resource allocation by polluters

The cost of meeting the federal government's proposed regulations on BOD, TSS and toxicity have been calculated for Environment Canada by Neil McCubbin Consultants and published in a report entitled *Economic Impact of Proposed Regulation of Pulp and Paper Industry BOD, TSM and Toxicity, Organochlorines, Dioxins and Furans*[37]. The estimated costs for Ontario's pulp and paper mills are summarized in Figure 3.12.

Figure 3.12


Capital Cost per Tonne of Production to Meet Proposed Federal Standards for BOD, TSS and Toxicity
(thousands of dollars)
(Ontario Mills)
$250
$200
$150
$100
$50
$0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

Source: Environment Canada

The chart does not include 10 mills for which the cost of meeting the regulations is either nil or very small. The range in capital costs per mill is quite wide, from a high of $240 per tonne of total annual output[38] to a low of nil. In addition, companies will have to pay operating costs which have been estimated at an average of $7.40 per tonne of

[37]Environment Canada, Regulatory and Economic Affairs Division, June 1990.

[38]To arrive at this figure, we divided the expected capital cost of investment by the total annual production of the company. For example, the cost of $240 was calculated by dividing expected capital costs of $29.8 million by annual production of 130,680 tonnes of product.

production. The amount which each mill must pay is a function of many variables such as products made, process used and the state of existing pollution control equipment.

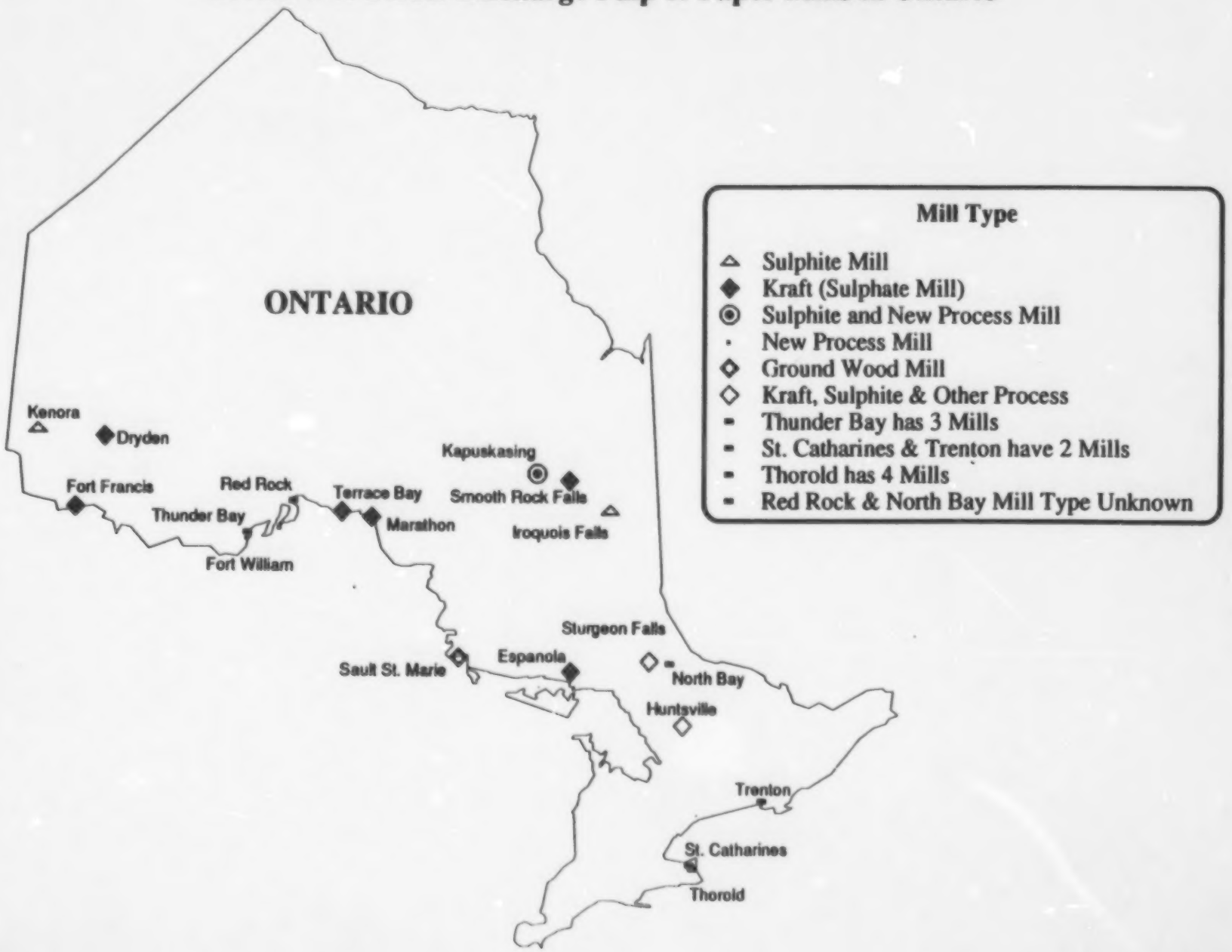
The fact that the cost per tonne of output and tonne of BOD is different for each mill suggests that resource allocation is not as efficient as it might be under an economic instruments approach. One reason for this apparent inefficient resource allocation might be that once a secondary water treatment system is installed, the amount of BOD emitted is reduced significantly. For example, the E.B. Eddy Forest Products mill at Espanola has a capacity of some 1,100 tonnes of output today, using a kraft process. The mill is equipped with secondary water treatment and, as a result, the BOD output is less than 2 tonnes per day compared with a proposed federal limit of 13 tonnes per day. By comparison, the James River mill at Marathon produces some 440 tonnes per day of kraft pulp with BOD emissions of about 15 tonnes (the proposed federal limit is 6 tonnes per day). This mill does not have secondary water treatment. The combined output of the two mills is some 17 tonnes of BOD per day, while the combined limit under the proposed federal regulations is 19 tonnes per day. It might be argued that, under a marketable permit system, the two mills would be able to meet the limits for BOD emissions at no extra capital cost to either company.

This analysis suggests that not all mills should have to install secondary water treatment systems. If the reductions achieved by an aerated lagoon will reduce the BOD levels of the wastewater of any mill well below the proposed limits, then it is conceivable that two mills sharing the same water system might need only install a treatment system at one of the mills in order to meet the total proposed limit for that watershed and trade permits from one mill to the other.

However, the potential for trading permits or pollution charges is limited by the number of mills within a given watershed. The question of how many and which mills would be allowed to pollute can only be answered by a technical analysis of emissions and the impact on fish and other wildlife living in the watershed affected by BOD emissions. Figure 3.13 shows the sites of pulp and paper mills in Ontario. There are three areas where mills are congregated such that their effluent empties into the same water system. These are:

- the Niagara region where four mills empty in the Welland Canal/12 Mile Creek System;
- the Trenton area where three mills empty in the Bay of Quinte; and

Location of Direct Discharge Pulp & Paper Mills in Ontario



- Lake Superior where several mills empty in the lake at various points.

None of the mills in the Niagara region require capital investment to meet the proposed federal regulations and, therefore, it can be assumed that there would be no need for economic options in this circumstance. In the Trenton area, there is a potential for trading between two mills, one of which emits BOD levels considerably below the proposed allowable limit, and the other which is currently well above that limit. We do not know to what extent trading of marketable permits might be feasible for those mills bordering Lake Superior. There are clearly mills whose current emissions are well below the proposed allowable limits and which would have permits to trade to others with emissions well above those limits.

Bonsor (1990) argues that industry-wide blanket standards also promote inefficiency in terms of over- and under-control at different sites, due to the failure to account for differences in the valuations placed on cleanliness of different receiving waters, and the degree of dilution in these waters. This would also be a problem in an pollution tax system that failed to set differing rates on each source, an approach that would be difficult to implement in practice. Similarly, a marketable permits system would also require a different total level of permits for each water body.

iii) system adaptability

Changes in command and control legislation involve setting new and lower standards for mills. In Ontario, command and control has adopted a 'mill by mill' approach in setting standards and, as such, has been able to address the unique circumstances of each mill. This type of legislation has demonstrated flexibility.

Federal legislation, by setting different standards for newly constructed mills, modernized mills and old mills, has also demonstrated flexibility in its approach.

The pulp and paper industry has complained in the past that command and control regulations have been too expensive to implement. For example, the industry currently estimates that the cost of meeting the proposed federal regulations on BOD, TSS, toxicity, organochlorines, dioxins and furans will equal some $4 to $5 billion in capital costs alone. An Ontario Ministry of the Environment report on pulp and paper regulations cited industry complaints of high costs of abatement facilities, the cyclical nature of the business and the

short time-frame for compliance when early control orders were introduced[39]. The federal government's initial approach of three separate standards was more responsive to industry needs, although its impact on the environment was probably much less significant than it might have been if it had not been as concerned with socio-economic considerations[40].

iv) capacity to generate technological innovation

According to the Canadian Pulp and Paper Association, annual capital spending in Ontario to control waste discharges into water ranged from some $17 million in 1978, to a high of over $30 million in 1981. Capital spending fell considerably after that year, probably due to depressed markets and high interest rates.

Capital spending on new technology was helped considerably by the joint Federal/Provincial modernization program which supplied grants to the industry to upgrade existing technology. Environment Canada estimates that this program was probably responsible for 30% to 40% of the reduction of effluents at some mills. Because of the existence of the program, it is difficult to assess the impact which command and control legislation might have had on technological innovation without a capital grants program.

v) capacity to induce research and development

Industry investment in research and development during the 1970's and 80's was influenced by government support programs which offered incentives to companies in the industry. The *Co-operative Pollution Abatement Research* program was initiated in 1971 and received more than 900 applications from the industry over a 10 year period. The *Development and Demonstration of Pollution Abatement Technology* program provided up to 50% of the cost of a project to demonstrate new pollution abatement and control technology within the pulp and paper industry. Industry and government together spent some $14 million under this program.

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[39]E.W. Turner, *Current Developments in Ontario Pulp and Paper Industry Regulations*, Pulp and Paper Sector, MISA Program, Ontario Ministry of the Environment. No date given.

[40]For a discussion of the socio-economic concerns of federal legislation, see William F. Sinclair, *Controlling Pollution from Canadian Pulp and Paper Manufacturers: A Federal Perspective*, Environment Canada, March, 1990.

These support programs encouraged capital spending on R&D and make it difficult to assess the impact which command and control legislation might have had on research and development without such support. Both Canadian Pacific and Abitibi-Price, two of the larger pulp and paper companies in Ontario, reported that they rely primarily on outside companies for research and development of new technologies. However, their approach may have more to do with management policy than with environmental legislation.

vi) requirements for, cost of, and frequency of monitoring, enforcement, and administrative activities

Under current command and control regulations, each mill is responsible for providing the Ministry with reports of mill effluent, as described in their Certificates of Approval. The Ministry undertakes quarterly audits to ensure that the information provided is accurate. Under MISA the amount of monitoring required is expected to increase because the number of characteristics which will be monitored will grow. Those district managers for the Ministry with whom we spoke did not expect that monitoring costs or activity would be any greater or less under command and control than for a system using economic options since both legislative approaches would require similar reporting and monitoring. We would point out that these managers have no direct experience with administering economic instruments.

Ministry personnel with whom we spoke believe that marketable permits might require an increase in administrative effort and costs because of the need to monitor the trading of permits.

vii) public, private and interest group perception

For the most part, interest groups believe that command and control has not been effective in improving environmental performance in the pulp and paper industry. There is a perception that standards and targets are set without public input and, therefore, industry has had too much influence on control orders. This is not necessarily a criticism of command and control legislation, but rather a comment on the way in which control orders have been established. It is our impression that, in general, interest groups would be satisfied with stricter command and control legislation.

None of the interest groups with whom we spoke expressed a strong opinion on the use of economic options for control of BOD. Their main concern was that permit trading

or taxes on emissions should take into account watersheds and local effects. Some doubt was expressed that it would be possible to define watersheds in a way that would not have some negative impacts. For example, while two mills might be on the same river, and therefore in the same watershed, allowing one of the mills a higher level of emissions might have a severe negative impact on the environment of those living in the immediate vicinity of the mill, even though the 'watershed' as a whole receives the same level of effluent.

Ministry personnel expressed their own frustration with the current command and control system. While control orders have induced those polluters who are far above the norm to reduce emissions, they have not been able to significantly reduce overall levels of pollution. One of the reasons for the difficulty experienced by control orders is the ability of companies to appeal the order and the difficulty which the Ministry faces in justifying its standards at the Environmental Assessment Board level. The MISA program is expected to avoid this problem because regulations arising from the MISA program cannot be appealed, although MISA will still face the problem of appeals when charges are levied against companies who exceed emission levels.

The Ministry personnel at the regional level with whom we spoke were non-supportive of economic options, either marketable permits or taxes on emissions. There was concern from this part of the Ministry that economic options would require additional administrative staff and would face a negative reaction from industry, although this was only a perception and not based on a complete analysis of economic instruments. Furthermore, the Ministry is devoting all of its efforts to implementing the MISA program and would find it difficult to adopt a new approach at this stage.

Industry perspectives on marketable permits or taxes varied. While it is recognized that there are possible economic benefits to economic instruments, in particular marketable permits, there are also barriers to their successful adoption. These include both public perception and a lack of companies with which to trade.

viii) suitability and effectiveness as public financing mechanisms

No revenues were raised through this program.

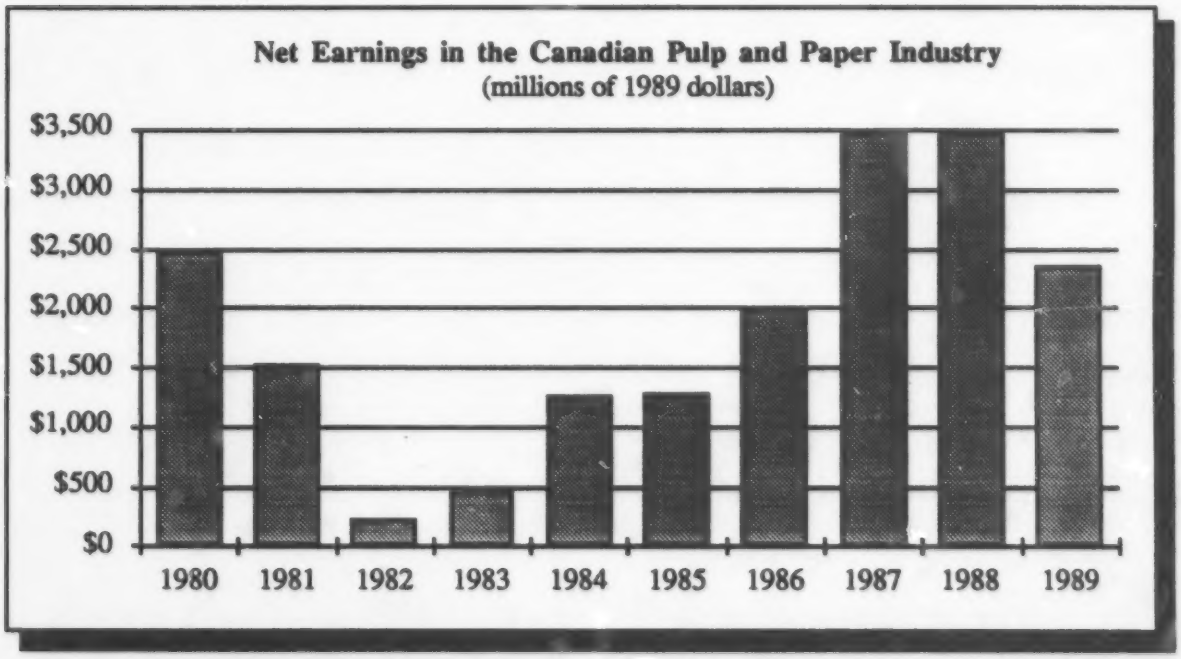
ix) implications for international trade competitiveness

Canada is one of the world's leading exporters of pulp and paper, exporting between 70 and 80% of its total pulp and paper production. The ability of the industry to

absorb costs for environmental protection and remain competitive in international markets is, therefore, very important.

The impact of new standards on the industry will vary considerably by company. Out of 27 pulp and paper producers in Ontario, 12 would require little or no capital investment to meet the proposed federal standard for BOD. At the other end of the scale, it is estimated that the most expensive capital investment would equal some $240 per tonne of annual output. These investments are largely unproductive in nature and, therefore, there is little opportunity for the company to recoup its investment through operating efficiencies.

Figure 3.14



Source: Canadian Pulp and Paper Association, mimeo.

Figure 3.14 illustrates the cyclical swings of the pulp and paper industry, as well as the sometimes low net earnings of producers. This is an indication of the tightly competitive market in which the industry operates and the need to take the cost of meeting the regulation into account when introducing legislation.[41]

[41]Ontario in fact conducts such analyses for all environmental programs it undertakes.

3.5 Price Instrument Case Studies

3.5.1 Provincial and Federal Taxes on Leaded Gasoline

Legislative Background

Leaded gasoline, when burned in automobiles, creates lead emissions which are toxic. As a result, governments have steadily worked towards reducing lead emissions from automobiles since the 1970's. Initially, these efforts focused on the automobile itself, with mandatory production of emissions control devices and cars capable of running on non-leaded fuel. However, while the number of vehicles capable of using non-leaded gasoline increased steadily during the period 1972-1988, surveys of gasoline consumption in Ontario in the mid 1980's indicated that many consumers were still using leaded fuel. One of the reasons for this continued use of leaded fuel was the fact that leaded gasoline was, on average, three cents per litre less expensive than non-leaded gasoline.

Governments elsewhere have commonly applied higher taxes on leaded gasoline in order to eliminate this price advantage.[42] The Netherlands adds close to 8¢ (U.S.) per gallon in additional taxes on leaded gasoline, and uses the revenues to pay for environmental programs. Differential charges are also imposed in Denmark (20¢ per gallon), Finland (21¢), Germany (4¢), Norway (18¢), Sweden (9¢), and the United Kingdom (20¢).

Following a similar policy, in response to environmental concerns about leaded fuel, Ontario applied an additional three cent per litre tax on leaded fuel in May, 1988 to encourage greater use of non-leaded fuel. The stated objective of this tax was purely environmental, although tax revenues did increase because of the tax. The Ministry of Treasury and Economics estimated a revenue increase of $39 million in the 1988-89 fiscal year. The incremental revenue from this tax was projected to decline steadily through 1993, which was the target date for elimination of all leaded automotive fuel.

The federal government applied an excise tax to leaded gasoline in May, 1989. This one cent tax was applied for much the same reason as the provincial tax, i.e. to reduce the use of leaded gasoline. By the time this tax was announced, the federal government

[42] Anderson et al (1989) provided the examples we cite here.

had shifted the date for elimination of leaded gasoline to December, 1990. Because of the small amount of the tax, its short duration, and the belief that refineries were expected to reduce production of leaded gasoline over the course of 1990 in anticipation of its eventual ban, the tax was not expected to have a significant impact on consumption of leaded gas or federal revenues.

Other provinces also undertook similar moves to increase the price of leaded gasoline to consumers. Table 3.5 summarizes the incremental taxes imposed on leaded gasoline by the Canadian federal and provincial governments.

Table 3.5

Incremental Taxes on Leaded Gasoline in Canada

Jurisdiction	Date Introduced	Tax Rate (¢ per litre)	Estimated Revenue ($ Millions)
Manitoba	1985	0.9¢	N.A.
Manitoba	1988	1.8¢	$1
B.C.	1987	2.0	37
Canada	1987	0.3	30
Canada	1989	1.0	35
Ontario	1988	3.0	39
New Brunswick	1989	2.2	2
Newfoundland	1989	1.5	N.A.
Saskatchewan	1989	2.0	12

Source: Stone (1990)

Evaluation of the Taxes on Leaded Gasoline

i) capacity to protect and improve environmental quality

There are several factors which contributed to the gradual change in consumption patterns of leaded gasoline during the period in which the tax was in effect. One of the principal causes was the shift in vehicle type from those using leaded fuel to those using unleaded gasoline. Sales of regular leaded gasoline had been declining for several years prior to the imposition of the tax, largely due to the decline of vehicles capable of using

leaded fuel. After 1975, all North American cars were designed to use unleaded gasoline, although a few later models and imports were capable of using both leaded and unleaded fuel.

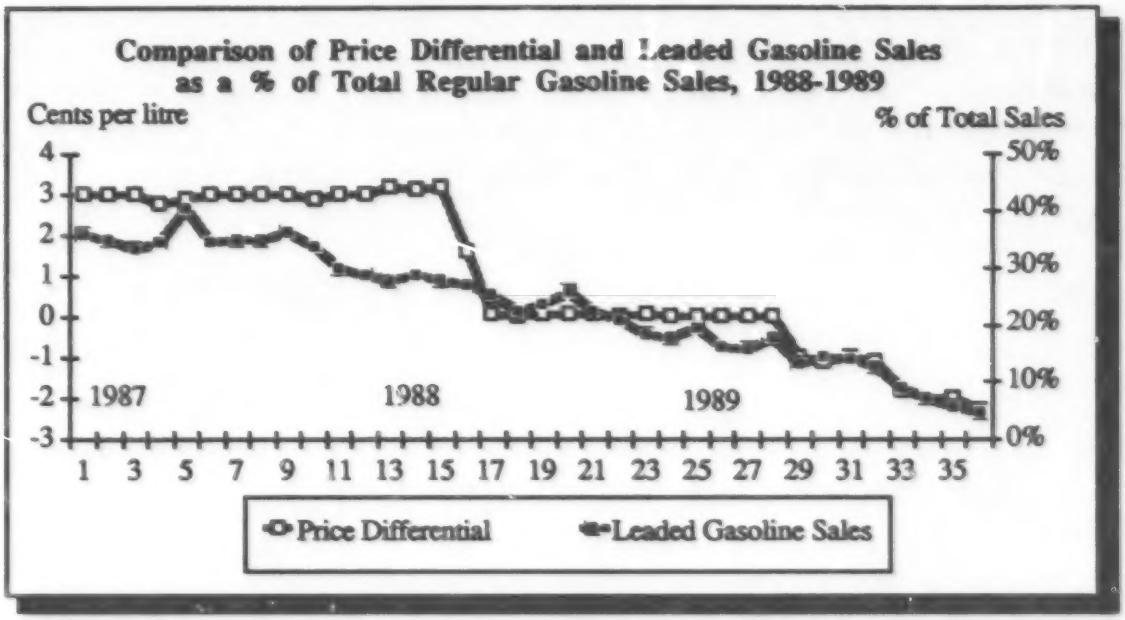
The legislation banning leaded gasoline after 1991 also led many suppliers to phase out leaded gasoline production at refineries in the 1990 year. The scarcity of leaded gasoline at the fuel pumps likely convinced many consumers using leaded fuel to switch to unleaded for reasons of convenience and therefore accelerated the purchase of leaded fuel. Introductions of unleaded gasolines designed to achieve some of the superior vehicle performance characteristics of leaded gasoline may also have had an impact in reducing sales of leaded gas.

Thus, there were many influences on the decision to switch to unleaded gasoline, and it is not possible to ascertain the impact of the tax with any precision. However, it appears likely that the provincial and federal tax on leaded fuel had only a small effect on the purchase of leaded fuel over the two year period in which they were in place and that most of the decline in consumption was caused by changes in vehicle type and the scarcity of leaded fuel at retail outlets.

Figure 3.15 illustrates the consumption of regular leaded gasoline as a percentage of total regular gasoline sales (leaded and unleaded) and the price difference between regular leaded and unleaded gasoline for a three year period from the beginning of 1987 to the end of 1989. Sales of leaded gasoline had declined steadily several years before the 1988 tax was applied. From 1985 to 1987, consumption of leaded gasoline in Ontario had fallen from some 5 million cubic metres per year to 3.6 million, while, at the same time, total annual gasoline sales in the province increased from 11.8 million cubic metres in 1985 to 12.2 million in 1987. The addition of a tax on leaded gasoline in May, 1988 does not appear to have affected this long term trend.[43]

[43]Indeed, sales of leaded gasoline as a percentage of total gasoline sales actually increased slightly in the first few months after the tax was added. This is likely due to seasonal factors which typically increase the leaded fuel share from May to August, namely, the increased use during these months of recreational vehicles, such as all terrain vehicles and motorcycles, and other power equipment using leaded gasoline. The same phenonmenon occurred in 1989 when the federal tax was added making the price of leaded fuel more expensive than unleaded.

Figure 3.15



Source: Statistics Canada

There is some evidence to suggest that the tax might have been more effective in reducing leaded fuel consumption had it been designed to increase the price of leaded gasoline above that of non-leaded fuel rather than making the price of the two products equal. In the latter part of 1989, when the price of leaded gasoline was 2 cents per litre higher than that of unleaded gasoline, sales of leaded fuel fell more sharply than in any other period. Of course, the increasing scarcity of leaded gasoline at retail outlets during this period probably contributed to the decline in leaded gasoline sales.

ii) efficiency in resource allocation

The added tax on leaded fuel can be viewed as an alternative to a command and control approach, which would have entailed the establishment and enforcement of regulations banning the use of leaded fuel by vehicles designed to take unleaded gasoline. In practice, such an approach would have likely required considerable resources for effective enforcement.

The tax can also be viewed as a means of moving towards "full cost pricing"[44] for leaded gasoline, by imposing the cost to the environment of leaded gas on consumers of such fuels. It is clear that the level of the tax was not set to correspond to any calculations of environmental costs (as would be the case if one were attempting to set an economically efficient tax). However, since leaded gasoline use imposes greater environmental problems than unleaded gasoline, an economically efficient tax would entail at least some degree of higher taxation on leaded gasoline, as was the case in the policy that was implemented.

The tax imposed an equal price penalty on all users of leaded gasoline. There was therefore no attempt in this case to differentiate among regions where lead in the environment posed a greater problem.

However, the response to the system by drivers does permit flexibility in terms of the degree of response by individual drivers, relative to an outright ban on leaded gasoline, for example. Those whose vehicles could not take unleaded fuels, or who had a strong preference for leaded gasoline on performance grounds, could continue to purchase such fuels (at least in the short-run) and pay the extra cost. The users who placed the least additional value on using leaded fuels would have been those who opted to shift to unleaded fuels in the face of the tax. Thus, the reduction in the use of leaded gasoline was achieved in a manner that minimized the overall cost of switching to unleaded gasoline.

iii) system adaptability;
iv) capacity to generate technological innovation; and
v) capacity to induce research and development

These criteria are not applicable to this case, in view of the short time span in which the program operated. Both the federal and provincial tax were implemented with the knowledge that lead in gasoline would be subsequently phased out.

[44]Economists also use the term "internalizing" what would otherwise be an "externality", i.e. making the consumer pay for a cost that would otherwise fall on other members of society. In the absence of such a step, the economy will overproduce the product generating the externality (i.e. leaded gasoline) relative to the cleaner alternative, since consumers will weigh only the private benefits and private costs (as opposed to the costs borne by others) when selecting their level of consumption. Note also that existing taxes on both unleaded and leaded gasoline were already high relative to other goods, and thus one cannot be certain that these taxes were not already both above an economic optimum designed to incorporate externalities associated with vehicles. The evidence only enables us to conclude that the tax on leaded gasoline should be higher than that on unleaded gasoline.

The one significant change which occurred over the life of the tax was a decline in revenues as sales of leaded gasoline fell. This change, however, was anticipated when the tax was introduced. The phase-out of the manufacturing of automobiles that use leaded gasoline was already well underway when the program was instituted, and was not affected by it.

vi) requirements for, cost of, and frequency of monitoring, enforcement, and administrative activities

No additional administrative or monitoring requirements were required by these taxes at either the provincial or federal level, beyond those already in place to collect provincial and federal sales taxes on gasoline. Other mechanisms (inspections and fines, etc.) for ensuring that unleaded fuel was used by all vehicle owners whose cars were designed to use it would have entailed some enforcement or administrative costs. Operating on the price of the undesired commodity (in this case, leaded gasoline) can be a very cost effective means of discouraging consumption.

vii) public, private sector and interest group perception

The tax on leaded gasoline was introduced in response to the concerns of environmental interest groups. We are not aware of any groups that publicly opposed this measure.

vii) suitability and effectiveness as a public financing mechanism

Although the tax did not contribute significantly to public financing at either the federal or provincial level, some revenues were raised through the tax. In Ontario, revenue expectations were some $39 million in the 1988/89 fiscal year and the province believes that the actual revenue was somewhere in this range. The federal government forecast revenues of $35 million in the 1989 calendar year and $20 million in the 1990 calendar year from the excise tax increase one cent per litre.

The revenues were likely raised to a greater extent from drivers of older vehicles that were legitimate users of leaded gasoline (as opposed to those whose vehicles were designed for unleaded fuel but were primarily using leaded gasoline for price reasons). To some extent, these drivers might have been of below average income relative to the driving population as a whole, and therefore the tax, as is often the case with sales taxes, may have

been somewhat regressive. This was likely not a major concern in this context, due to the modest nature of the total cost to individual drivers over the short lifespan of the program.

ix) implications for international trade competitiveness

Environmental protection policies instituted through charges or taxes placed on the consumption of a product or on the level of emissions have been criticized on the grounds that they impose competitiveness penalties relative to firms in jurisdictions lacking such charges. In contrast to marketable permits or command and control systems, where a complete phase out in consumption or emissions is not the objective, charges will pose a financial cost on firms *in addition* to the costs associated with abatement or conservation activities.

In this case, the price of fuel has an indirect impact on Ontario's international trade competitiveness, as higher fuel prices increase the cost of manufacturing and shipping goods. We would expect, however, that the impact of this particular leaded gasoline tax on competitiveness was very small, since very modest revenues were raised from industries through the tax.

More broadly, the entire tax burden on motive fuels, which is much higher than the taxes placed on other consumption goods, can be thought of in part as an environmental measure designed to promote conservation. The overall level of taxation on gasoline does play a role in determining the competitiveness of a number of Canadian industries, with transborder trucking being the most directly and negatively affected sector. Shippers of other exported products also pay higher prices to cover the cost of fuel used in transportation, which may not be borne to the same extent by imports who use carriers that fuel their vehicles in the U.S.

3.5.2 Water Effluent Charges in Germany, France and the Netherlands

European countries have tended to be leaders in the use of charges and taxes as a means of encouraging environmental protection. France has had a charge on sulphur dioxide emissions since 1985. The Netherlands, Norway and Sweden have made use of "product charges", which are differential sales taxes applied more heavily on products deemed to be damaging to the environment.

Three countries – France, the Netherlands and Germany – have made use of charges on effluents as part of their water pollution control policies. The French and Dutch

systems were primarily designed to raise revenues, although the latter has had important incentive effects, as we discuss below. The German system is unique in being designed expressly for the purpose of creating incentives for environmental protection.

In a pure market instrument approach, an effluent charge would be the sole element of environmental policy, with each firm or municipality free to determine the extent to which it would reduce or even increase discharges in the face of the charge.

None of the three countries in this case have adopted such an approach. In each case, the primary mechanism for regulating water quality is a command and control system of licenses. Charges only serve to create an added incentive (beyond other possible penalties for violations) for complying with the command and control regulations, and an incentive for exceeding them.

History and Description of the Programs

Germany[45]

Effluent charges were enacted in 1976, and implemented in 1981[46], to control water pollution in Germany. The pressure to improve water pollution control efforts came from both the German public and the international community. Water quality had been so eroded by industrial activity that water bodies were becoming unsuitable as sources for drinking water. There was also pressure placed on Germany by downstream countries (Switzerland and the Netherlands).

Market-based approaches to this problem were first recommended by a federal level cabinet committee in 1971, and charges had been previously used in some Länder (states).[47] As a result of a compromise between the federal government and the Länder

[45]This section is based on Brown and Johnson (1983) and Opschoor and Vos (1988).

[46]The delay between the enactment in 1976 and the first year of collections in 1981 was designed to give dischargers time to respond with investments to reduce their effluent volumes.

[47]Bower et al (1981) describe the system in place in the Länd of Nordrhein-Westfalen. These levies were not true effluent charges, since they were fixed charges that were based on industry average effluent levels per unit of output or employment, rather than on the firm's own effluent level. A firm could therefore not avoid the charge through abatement activity, and thus the charge did not create incentives for effluent reductions.

(states), a mixed approach using command and control and effluent charges was ultimately selected.

The Federal Water Act (FWA) and the Effluent Charge Law (ECL) were enacted in 1976 to implement this mixed approach. The FWA authorized the federal government to impose technology-based standards for waste water treatment. Individual standards, reflecting best practicable or commonly accepted technology, were created for each type of industry and for municipalities. The law placed the legal liability for damages done to others on the polluter, and also set fines of up to 100,000 DM for violations of the law.

The ECL called on Länder to impose charges on direct discharges of specific effluents into public waters, particularly fresh water. Firms and households discharging into public sewers are not covered directly, although there may be a weak link between the charge imposed on the municipality and its charge to sewer users.

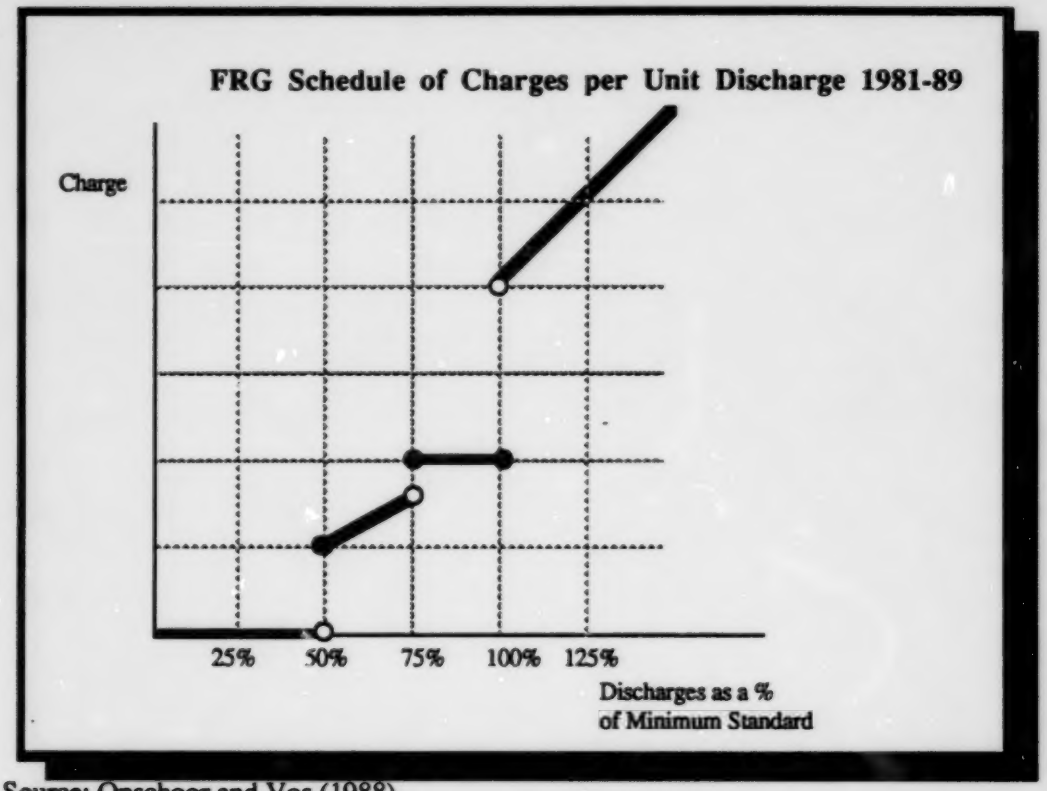
Charges were first imposed in 1981. The Länder issue discharge permits to each source, stipulating a discharge right in terms of waste water quality (pH, BOD, toxin concentrations, etc.) and volume (per hour, day, year), at a quality that meets or exceeds the federal standard. Charges currently cover 11 types of discharges.[48]

The permit also establishes a bill that the firm must pay for the discharges. As shown in Figure 3.16, the charges are discontinuous, with the firm receiving a lower rate if it meets the standard or achieves levels more than 75% below the standard.[49] Since 1989, a firm achieving a discharge rate below 50% of the standard is exempt from paying charges. A hardship clause also exempts industries, sections of industries, or regions where the federal government deems that the charges would result in significant economic difficulties.

[48]There were six pollutants covered in 1981: settling substances with ≥ 10% organic content, settling substances with <10% organic content, oxidizing substances, Mercury, Cadmium and toxics affecting fish. Five new categories were added in 1989: AOX, Chromium, Nickel, Lead and Copper.

[49]As shown in the chart, the rate is reduced by 50% for firms meeting the standard, and the payment is constant between the 75%-100% of standard range (i.e. firms making small reductions below the standard do not see a reduction in rates. As we discuss later, this serves to reduce the need for accurate monitoring for firms meeting the standard.

Figure 3.16



Source: Opschoor and Vos (1988)

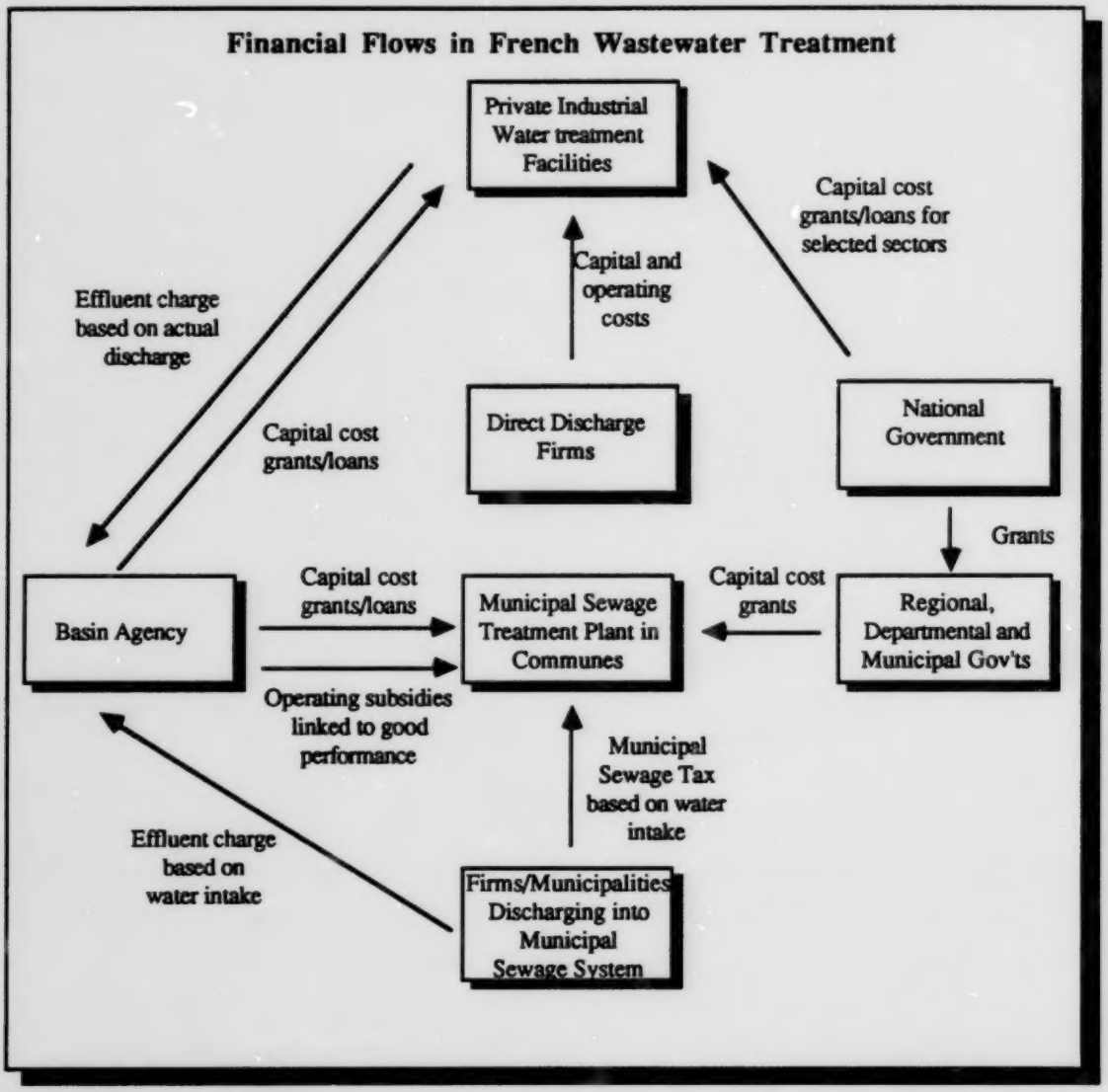
France[50]

The French system of water charges is not expressly designed to create incentives for environmental protection. Rather the two types of charges levied (effluent charges and sewage taxes) are designed to generate revenues for water basin agencies and public wastewater treatment plant operators, and the rates are set based on overall revenue targets. The basin agencies are financing institutions which have a mandate to levy charges on water users and to make grants and loans to cover part of the capital and operating costs of wastewater treatment facilities for firms and municipalities. Municipalities or groups of municipalities are responsible for the construction and operation of sewage treatment plants, and some industrial water users also treat their own effluents.

[50]This description of the French water charges is based on Bower (1983), and Bower et al (1981).

Figure 3.17 illustrates the flow of funds among the various participants in the French wastewater system:

Figure 3.17


Financial Flows in French Wastewater Treatment
Private Industrial Water treatment Facilities
Capital cost grants/loans for selected sectors
Capital and operating costs
Effluent charge based on actual discharge
Capital cost grants/loans
Direct Discharge Firms
National Government
Grants
Basin Agency
Capital cost grants/loans
Municipal Sewage Treatment Plant in Communes
Capital cost grants
Regional, Departmental and Municipal Gov'ts
Operating subsidies linked to good performance
Municipal Sewage Tax based on water intake
Effluent charge based on water intake
Firms/Municipalities Discharging into Municipal Sewage System

Source: Bower et al (1981)

The rates for the effluent charge on firms that are direct dischargers (those firms not discharging their wastes into the sewage system but directly into bodies of water) are based on actual discharges per unit of production. Charges are set on each of six types of discharges: total suspended solids (TSS), oxidizable materials (OM), soluble salts, toxics,

nitrogen and phosphorous (with the last two added in 1982). With some exceptions, actual measurements of discharges on up to four days are used to determine a firm's discharges per unit of production, with re-sampling done at the request of either the firm or the basin agency. A rebate can be paid to firms operating their own treatment plant based on its degree of removal of TSS and OM. Where an ambient water quality target has been established, the firm earns an additional rebate only for reductions required to achieve a maximum permissible discharge; further reductions do not add to the rebate.

The effluent charges placed on municipalities by the basin agencies, and the sewage taxes imposed on households and indirect industrial dischargers (those discharging into municipal sewers), are not as directly linked to environmental performance. The effluent charge placed on municipalities by basin agencies is based only on the number of persons and firms linked up to the system and the location and size of the city. The charge is actually paid by the water distribution company operating in the area, which collects the fees from the municipalities it serves.

Households and firms linked to the municipal system pay a sewage tax to the municipality and and effluent charge to the basin agency, but these are related only to their water intake, not their discharges.[51]

The Netherlands

A number of charges are imposed in the Netherlands on water users and wastewater generators. Our focus is on those imposed under the Pollution of Surface Waters Act of 1970, since it has been in effect long enough for evidence to be generated on its impact.

As in France, charges were imposed as a part of a "polluter-pay" policy to generate funds for water purification, rather than with the express intent of creating abatement incentives. Each firm pays a fee based on its discharges, measured in pollution units known as "inhabitant-equivalents", based on the organic effluents produced by a typical person.[52]

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[51]Details on the formulae used to set all of the charges are in Bower et al (1981).

[52]Households, as well as small industrial waste generators (those with discharges of less than 10 inhabitant equivalents) faced a fixed fee (based on 3.0 or 3.5 inhabitant equivalents). There is therefore no incentive effect for household or small business wastewater generators. Some firms also pay a charge on heavy metal

The level of the fee is set to meet revenue objectives, which in turn reflect regional requirements for building and operating wastewater treatment plants. Thus, the charge per inhabitant equivalent has varied across regions, and has increased over time as abatement goals and costs have risen. For example, the charge rose from about $4 (U.S.) per unit in 1971 to $15-$20 (U.S.) by 1980.

Evaluation of the Effluent Charge Programs

Since the effluent charges in all three cases were imposed as an addition to command and control regulations, there are two possible methods of evaluating their impact: 1) relative to what would have occurred with the same regulations and no charges; or 2) relative to a tightening of regulations designed to achieve the same total additional abatement effort (potentially allocated differently across firms) as induced by the charges. While we refer to both types of comparisons in the following analysis, it is clear from the history of their imposition that charges were not viewed as a substitute for a tightening of regulatory requirements in any of the cases under study. Therefore, we focus primarily on the first type of comparison.

i) capacity to improve environmental quality

Viewing charges in Germany, France and the Netherlands as supplements to command and control regulations, they could not have had negative implications for environmental quality.[53] If regulatory standards would not have been tightened in the absence of charges, the issue is whether the charges created an incentive for abatement that was sufficient to induce firms or municipalities to exceed standards or meet them more rapidly than would otherwise have taken place. The evidence suggests that charges have had a significant impact on environmental quality in the Netherlands, an uncertain although likely modest impact in Germany, and a small impact in France, with the differences primarily attributable to different charge rates imposed in these countries.

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effluents, but this is not a major charge since it covers only the cost of measurement and potential damage to the sewage treatment plant.

[53]This might not be the case if standards under the command and control approach were loosened due to a reliance on charges. However, as we noted above, only Germany viewed its charges as part of a policy to encourage abatement, and their introduction was accompanied by a general tightening of command and control policies.

Data on the impact of wastewater charges in **Germany** are limited, according to Hahn (1990), but the evidence suggests that they are likely to have had only a modest impact on water quality. Charge rates in Germany are only half of those in the Netherlands,[54] and averaged only 1/4 of treatment costs,[55] reflecting industry opposition to higher charges that had been discussed prior to the enactment of the legislation. A survey of water resource officials in government by Brown and Johnson (1984) found nearly unanimous agreement that the charges were set too low to be a major inducement for environmental protection investments by most firms.[56] According to Anderson et al (1989), even after increases in the 1980s, charge rates remain well below the average cost of treatment, thus providing an insufficient incentive for the majority of firms to reduce discharges beyond the minimum standards.

Even so, Brown and Johnson (1984) found that the charge program was still having an impact on firms and municipalities with low abatement costs. BASF, for example, has chosen to reduce charge liabilities by reducing discharges beyond the levels required by regulation, due to the low unit abatement costs it faces using large scale, integrated treatment processes. Surprisingly, one third of municipal authorities cited the charges as the primary reason for undertaking more extensive investments in wastewater treatment, and 20% accelerated plans they already had as a result of the impending charges. In view of the modest level of the charges, we suspect that these survey results may be overstating the actual impact of charges. Opschoor and Vos (1989) attribute these impacts in part due to the anticipation of the potential for higher charges in the future.

In addition to these direct effects, charges in Germany are creating incentives for abatement by some firms that discharge into municipal sewage systems. Faced with charges on their own discharges, one-quarter of municipalities surveyed have changed the

[54]Anderson et al (1989)

[55]Opschoor and Vos (1989)

[56]The charge rate was 12 DM per damage unit in 1981, rising to 40 DM in 1986. The latter would be about 22 DM in 1974 DMs. By comparison, the Council of Experts for Environmental Questions found that a charge of 40 DM as of 1974 would be sufficient to induce a 73% removal level (Brown and Johnson, op cit).

structure of their own water and sewage fees to provide more incentive for firms and households to conserve water use or discharges.[57]

Charges in **France** were also set at levels that were quite low relative to abatement costs. As of 1983, for example, the total value of the charges collected amounted to only $2 (U.S.) per capita, as opposed to $6 (U.S.) in Germany and $17 (U.S.) in the Netherlands.[58] Thus, relative to these other cases, there is less evidence of any impacts of charges on environmental performance in France.

Table 3.6 shows that the reductions in charges and subsidies received by a municipality for going to primary and secondary treatment are insufficient to cover the added costs of doing so relative to a "no treatment" policy. Similarly, for direct discharging industrial firms, Bower et al (1981) showed that the charge rates would have to be increased by a multiple of 4.5 to induce primary treatment, by 7 to induce secondary treatment, and by 14 to induce tertiary treatment. That is, these increases would be necessary if the cost in effluent charges to the firm for not engaging in treatment is to exceed the marginal costs of treatment facilities, even taking the subsidies for these facilities into account. As a result, some basin agencies had difficulty finding projects to subsidize.

[57] The survey is cited by Brown and Johnson (1984).

[58] These estimates are reported in Hahn (1990).

Table 3.6

Costs of Wastewater Treatment Options for French Municipality 1978[1]
(Annual Cost in $U.S. per Inhabitant Equivalent)

	No Treatment	Primary and Secondary Treatment
Effluent Charge	$2.33	$2.33
Less: Premium received for treatment	0	-1.63
Less: Superpremium for efficiency of plant operation	0	-0.35
Equals: Net Charge	$2.33	$0.35
Plant operating, maintenance and amortized capital costs	0	6.98
Less: Subsidy from Basin Agency	0	-0.70
Total Cost of Treatment and Charges	**$2.33**	**$6.63**

1. Costs are based on Seine-Normandy basin area, for a plant with 70% removal efficiency, with depreciation costs calculated on a 20-year straight line amortization.

Source: Bower et al (1981)

Most of the construction of wastewater treatment facilities has been induced by direct regulations (i.e. the command and control element of French policy) rather than as a response to incentives posed by charges. The charges play an environmentally beneficial role primarily as a means of raising revenues to pay for these facilities for municipalities and industries. The charges may also, according to Bower et al (1981) induce firms that have low cost options for abatement (i.e. short of a conventional treatment plant), such as in plant modifications or recycling, to increase their efforts in these areas. Examples cited

include slaughterhouses, paper mills, metal finishing and stone cutting plants, but we have not identified any concrete evidence of such responses.

Charges in **the Netherlands** are much higher than those in France or Germany, and have been shown to have a significant impact on abatement activities. Discharges declined from 40 population equivalents[59] in 1969 to a projected 4.4 population equivalents in 1985 (Hahn (1990)). Using a regression model for abatement by industry, Bressers (1984) found that 61% of the variation in abatement of organic discharges between 1969 and 1980 could be attributed to differences in the effective charge rates faced by these industries.[60] Hahn (1989) reported that this statistical evidence was confirmed by surveys of industries and water boards which found that charges were cited as important motivators of abatement activities.

ii) efficiency in resource allocation

The use of effluent charges as a supplement to command and control regulations has the potential for two types of *efficiency gains*:

1. The additional abatement promoted by the charges (over what would have been accomplished in any event due to the operation of the command and control system) is likely to occur where the costs of abatement are low relative to the charges. This would result in cost savings relative to a more general tightening of regulations for all firms and municipalities.

2 The funds raised through the charges are a substitute for other forms of taxation that discourage productive activity (e.g. income taxes which discourage labour supply or corporate taxes that reduce investment). We save the discussion of this issue for our review of the revenue implications of the charge systems.

If viewed relative to a targetted tightening of regulations, charges may also entail *efficiency costs* if the levels set do not reflect differences in the damages done by equivalent emissions at different locations. They might then result in abatement expenditures in locations where the environmental impacts of discharges are low and a lack of activity where the damage per unit of emissions is high.

[59] i.e. 40 times the dishcarges that the household sector alone would produce before treatment.

[60] The effective charge rate was defined as the total charge (pollution units produced multiplied by the charge per unit) as a share of the value of production by the industry.

As a result of the low level of charges in France and Germany, and the resulting modest incentive impacts, it is unlikely that there have been any significant efficiency gains or losses associated with shifts in the allocation of resources to abatement activities. Hahn (1989) concluded that, for the same reason, in a wide range of applications of charges examined, "it seems unlikely that charges have performed terribly well on narrow efficiency grounds". As a result, there have been opportunities that were missed for cost savings. In Germany, one study estimated that a full reliance on charges (at rates more than double those actually imposed) would reduce total abatement costs by one-third relative to a uniform standard.[61]

The Netherlands has been an exception in this regard, since the charges did have a significant impact on where abatement efforts have taken place. Although data are not available, we would expect that the cost saving impacts would have outweighed any distortions caused by differences in damage per unit of pollution, since the charges were not in fact equalized across the country. Rather, the charges are based on revenue needs for new treatment facilities, which are are also likely to be related to the extent of damage being done by discharges. Thus, the charges are in part determined by command and control policy objectives for each water region, which in turn should reflect the environmental sensitivities of the bodies of water involved. Furthermore, the charges affect abatement efforts beyond those mandated by standards, which already reflect ambient water quality targets in a particular water body.

iii) system adaptability

In contrast to a pure command and control system where added abatement would only occur if regulations were changed, firms will alter their response to effluent charges as abatement costs change even if the effluent fees remain constant. Thus, for example, if abatement costs fall for a particular industry, it can choose to respond with added abatement efforts in order to reduce effluent charges. This type of response is more likely to have occurred in the Netherlands, where the charge rates have been higher relative to abatement costs, than in France or Germany.

[61]The study was conducted by the Council of Experts for Environmental Questions, and its results are cited by Brown and Johnson (1984).

The effluent charge rates may also be more readily adjusted by environmental policy makers than would be the case for regulatory requirements. Hahn (1989) also notes that the history of effluent charges shows that policy makers have generally been able to increase their levels once they had been introduced and in operation. This was the case in both Germany and the Netherlands, where rates have risen faster than inflation since their inception. In France, Anderson et al (1989) found that rates have fallen in real terms due to political opposition to them, perhaps reflecting the general weakness of the environmental movement in France relative to Germany or the Netherlands.

iv)capacity to generate technological innovation

The charge systems, in contrast to technology-based standards, left firms free to choose any method of abatement that would enable them to reduce their liability for charges. We have not identified any concrete evidence on the extent to which innovative approaches have in fact been used in the three countries under study. However, in view of the modest level of charges in France and Germany, it is likely that such approaches in these countries were restricted to low cost measures that could be used to reduce charges at the margin.

v) capacity to induce research and development

The addition of effluent charges to the command and control systems in these countries may have promoted some efforts by firms or municipalities to undertake research to develop low cost abatement technologies that could be used to avoid the charges. Opschoor and Vos (1989) credit the rapid growth of the clean water technology market, promoting efficient solutions to process management, to the charge system in Germany and the incentives provided for superior performance, although they offer no evidence of this linkage.

In practice, we believe that Hahn (1989) is probably closer to the mark in concluding that the low levels of the charges are likely to have meant that the impacts on research and development were very modest. The exception again may have been the Netherlands, although we have not identified any specific evidence of such impacts.

vi) requirements for, cost of, and frequency of monitoring, enforcement and administrative activities

Since all three countries under study added effluent charges as a supplement to command and control policies, the total administrative and monitoring costs were necessarily higher than under the command and control policy alone. However, these costs have not been viewed as a major impediment to the charge program in any of the three countries studied.

The charge system in **Germany** was implemented in conjunction with a new federal command and control program of standards, and thus cost estimates appear to include the administrative costs of both systems. At the low level of charges initially imposed, the administration of the charge system (including monitoring and enforcement) by the Länder, absorbed a significant share of the revenues raised – as much as 33-50% in the first year, and up to 20-25% thereafter according to Brown and Johnson (1984), although a 10% share was estimated by North Rhine Westfalia (Brown and Johnson (1983)). Heavily industrialized regions that had sophisticated environmental programs in place, and which generated large revenues relative to fixed administrative costs, were in the best position to reap strong net revenue gains after program costs.

In the longer term, the system has not proved to be a major administrative burden on the Länder. With the increase in charge rates in 1986, from 12 DM to 40 DM, we expect that the share of revenues absorbed by administrative costs has fallen somewhat. One Länder, Schleswig-Holstein, that had initially opposed the charge system in fear of very high administrative costs and technical capability requirements for their rural area, subsequently reported that it was far easier to implement than they had envisioned, and they now support the system. The revenues raised by the Länder help to offset the costs they faced in implementing the command and control system instituted by the federal government in Germany.

A number of features of the German charge system served to moderate administrative, monitoring and enforcement costs.[62] These features were part of a concerted effort to keep the system simple. First, administration is facilitated by the fact that the same discharge permit issued to the firm or municipality is the basis of both the command and control regulations and the effluent charge.

[62]The following is based largely on Brown and Johnson (1983) and (1984).

Second, monitoring costs are reduced since the charge is set based on the amount that the firm *expects* to discharge, rather than on a continuously-monitored actual discharge level.[63] The charge does not vary with discharges between 75% and 100% of the standard, and is zero for firms below 50% of the standard, so accuracy in these ranges is not required.

Third, monitoring and enforcement of the charges is undertaken in conjunction with the operation of the command and control program. The same periodic monitoring is used to identify firms violating the standards part of the policy as well as to adjust charges for firms that are exceeding the discharges they originally reported in their discharge permit. Rural Länder that lack sufficient in-house resources have successfully contracted-out this monitoring to private-sector firms. Since Länder gain revenues by identifying violations, the charge system contains a built-in incentive for the enforcement of standards that would otherwise be lacking.

Fourth, charges were designed to reflect criteria that were easiest to measure – COD was used rather than BOD for this reason, and measures of toxicity that were already in wide use were adopted.

The charge system in **France** does not require a major administrative apparatus for its implementation, since many of the charges are not actually linked to environmental performance. Private water distribution companies (e.g. Lyonnaise des Eaux) act as intermediaries, collecting the municipal effluent charge from municipalities and other water users[64] and submitting the revenue to the basin agencies. Public or private laboratories conduct periodic monitoring of both municipalities and direct discharging firms. In the case of the latter, the costs are borne by the firm if it is the party seeking a potential adjustment to its effluent fee based on treatment performance. As in Germany, much of the monitoring is also an important element of command and control program implementation.

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[63]This is not dissimilar to the operation of command and control programs, which often do not entail continuous monitoring. Rather, engineering designs and intermitant monitoring are used to establish the expected level of emissions (or the level per unit of production) and to ensure these are in compliance with regulatory requirements.

[64]Although the charge is related to effluents by the municipal sewage treatment facility, the collection of the funds is based on water intake.

According to Opschoor and Vos (1989) administrative costs for charges in **the Netherlands** have been very low, amounting to only 2% for charges imposed by the State and 4-9% for those administered by other bodies. Enforcement has been difficult for heavy metals, where ambient water quality problems are difficult to trace to their source, and there have been some disagreements concerning the method of estimating discharges from medium-sized firms (which are not directly monitored).

vii) public, private sector and interest group perception

Charge systems in the countries under study received a reasonable degree of support from various interest groups and government agencies, and this support has tended to grow after the implementation of the program.

In **Germany,** there were a number of factors that contributed to the support for these market based approaches within the government.[65] First, the remarkable post-war economic recovery in Germany has widely been attributed to the wholesale removal of state controls in 1948 and the adoption of a free-market system. This has resulted in great faith within the German policy establishment in the power of market forces. Second, both the OECD and the EC favoured the use of market-based programs for the environment. Third, federal officials drew upon the examples set by existing charge systems in the Rhur region, although these were primarily for revenue-raising rather than incentive creation purposes.

Charges were initially opposed by some industry groups, and supported by others. Supporters were found among firms with low cost abatement technologies available, firms that already had abatement technologies in place, or those who felt they had faced tougher enforcement than their competitors. As the system gained political support, industry groups that had been opposed shifted their attention to implementation issues.

Some Länder had opposed a shift from their existing command and control approach to a pure charge system that had been proposed in the early 1970s, but later bowed to the momentum in support of market systems and advocated a mixed approach using both regulations and charges, which was ultimately adopted. As noted above, some Länder had overestimated the administrative burden they would face under the new system, and became more supportive once it was in operation.

[65]The following analysis is based on Brown and Johnson (1983) and (1984).

Charges in **France** also faced industry opposition, although this was muted somewhat by the fact that the funds raised are partly used to finance water treatment capital costs for industry. Proposed increases have been strongly opposed by industries, according to Anderson et al (1989), despite the fact that these increases have failed to keep up with inflation since the charges were first imposed.

Similar opposition by some industry groups has been registered in **the Netherlands**. Environmental groups such as the Dutch section of Friends of the Earth International have also criticized charges as being viewed by firms as a purchase of a right to pollute, thereby hampering clean up efforts. As we discussed, the evidence suggests that in fact the charges are an important motivating factor for environmental clean up in the Netherlands. Some environmental groups have also criticized the low frequency of monitoring. Overall, despite these pockets of resistance, Hahn (1989) concludes that "charges have enjoyed widespread acceptance in a variety of arenas in the Netherlands."

viii) suitability and effectiveness as public financing mechanisms

All three countries have used the effluent charges as a revenue raising tool for environmental protection investments, particularly for public wastewater treatment facilities. The programs offer a number of advantages in this regard, aside from their impacts on pollution abatement activity.

- First, the revenues raised through charges are substitutes for other taxes that would likely have had negative economic consequences. Had the equivalent revenues been raised through personal or corporate income taxes, there would have been disincentives for labour supply, savings or investment, with commensurate economic costs.

- Second, imposing charges on waste generators is consistent with a move towards the "polluter pay principle". From an equity perspective, one might wish those whose actions result in the need for public investments in wastewater treatment to bear more or all of the costs of these facilities.

- Third, from a political perspective, taxes on activities viewed negatively, such as the generation of wastewater effluents, tend to meet less public resistance than other taxes with similar revenue raising capabilities. This same phenomenon is in part the explanation for the heavy tax burden placed on tobacco and alcoholic beverages in Canada.

The main disadvantage of charges, relative to other taxes, is that they are not closely related to any concept of "ability to pay". The German charge system has created (although not widely used) an exception for financially troubled firms or industries in reflection of

this fact. Where charges are imposed upon individuals, as in France, they are potentially a quite regressive form of taxation, since water use (the basis for the French charge) will be linked primarily to family size rather than income or wealth.

Charges in all three countries considered have served as a significant revenue source, although they have remained modest relative to other, traditional sources of tax revenue. French water charges raised a total of $265 million (U.S.) as of 1986. The German charges raised 350 million DM ($155 million U.S.) in 1981 (Brown and Johnson (1983)), while the Dutch charges raised 473 million ECU in 1985, more than double the French revenues in that year. To put these in perspective, the per capita revenue is about $50 in the Netherlands, and less than $6 in both France and Germany. (Opschoor and Vos 1989).

ix) implications for international trade competitiveness

One potential drawback of charges lies in their potential impact on industrial competitiveness, since the charges are a cost to businesses, over and above the costs they incur in abatement. This would particularly be the case where charges were the sole instrument for encouraging abatement activity, since for firms with high abatement costs, the charge per unit of effluent would have to be very high to encourage abatement. In the three cases under study, we do not believe that these effects have been significant, for the following reasons:

- The charges, particularly in France and Germany, are quite low relative to other corporate taxes, in part reflecting corporate resistance to charges that might impair their competitiveness, and the fact that in all three countries, regulations rather than charges were the primary policy instrument for promoting abatement by industry.

- The charges in all three countries are substitutes for other taxes that would have been imposed to raise revenues for municipal wastewater treatment, and thus the effects are primarily ones associated with a modest redistribution in favour of firms with low discharges;

- In the case of France and Germany, the funds raised from industry are in part used to fund subsidies to firms for wastewater treatment capital costs;

- In the case of Germany, there are substantial discounts for firms exceeding the standards, and firms that are either in economic hardship or below 50% of standard effluent levels are exempted from charges. The "kinked" charge schedule used in Germany is a useful means of having sufficient incentives for firms above a target level of effluent, while not imposing large costs on firms that have taken reasonable steps to reduce their discharges.

- In the Netherlands, an effluent charge on phosphates that would have placed a large burden on the fertilizer industry was rejected by regulators.

3.5.3 Solid Waste Charges in Seattle, Washington

Seattle, a city of roughly 500,000 inhabitants, faces many of the same difficulties associated with solid waste disposal that are currently confronting many of Ontario's major urban areas. The council has used a range of mechanisms, including the promotion of recycling, to avoid controversial and costly investments in energy from waste plants or landfill sites.

Of interest for this study is a system of charges imposed on residents to raise funds for waste management and in particular, with a view to encouraging residents to practice the 3R's: "recycling, re-use, and reduction". This case, in contrast to the effluent charge systems in Europe, demonstrates the use of charges as the primary instrument of environmental policy, rather than as a supplementary incentive placed on top of a command and control system. While we emphasize the Seattle experience, we also draw upon the results of a similar program in Perkasie, Pennsylvania.

History and Description of the Program

The "Variable Garbage Can Rate Structure" was first imposed on households by Seattle's Solid Waste Utility in 1970. The program was significantly enhanced in 1989, with improved monitoring of the number of cans placed at the curbside by households and recycling programs for newspaper, glass, plastics and metals. As currently structured, the program incorporates the following elements:

- A single family household pays a fee for service based upon the size of the garbage can used. The smallest size is a 19 gallon can and the fee for weekly pickup at the curb is $10.70 per month. The next size is a 32 gallon can for which the monthly fee is $13.75 and the largest size is a 60 gallon can for which the fee is $22.75. Each addition 9 gallons costs $9 per month.[66] Households that want backyard pickup pay an additional 40%. Extra waste must be accompanied by a tag, purchased at a cost of $5. "Blue-box" pick-up services are provided at no additional charge.
- Multi-family building owners also pay based on the number of cans they wish to put out each week;

[66] A higher charge is also imposed on residents for backyard (vs. curbside) pickup.

- Low income, elderly and handicapped residents obtain a subsidized rate for up to two can per week service equal to $4.30 for a 19 gallon can and $5.50 for a 32 gallon can. Backyard pickup service is supplied at no additional charge to low income, elderly and handicapped residents;

- Yard waste cannot be included in cans, and a charge of $2 per month is imposed on households requesting yard waste pick-up, with a maximum volume of 20 cans, bags, or bundles per month;

- There is a limit on the number of pounds per can, but no extra charge for cans which are heavier than the limit;

- A charge of $15 is imposed for the pickup of bulky items (major appliances, furniture).

A similar variable rate program was adopted in Perkasie, Pennsylvania. Prior to its implementation, households paid a fixed fee of $120 for trash removal. In this suburb of 6,500 people adopted a pay-per-bag system, where bags with a special decal must be used and the fee is charged upon purchase of the decal.

Evaluation of the Program

i) capacity to protect and improve environmental quality

The purpose of the variable rate program is to reduce the volume of waste sent to landfills or incinerators relative to the previous system of fixed charges per household. Thus, the environmental impact can be judged by the trends in per capita household waste generation since the program's inception.

Over 1970-1988, as charges per can have increased, the Solid Waste Utility recorded a decline in waste per household , from 1,800 pounds per household per year to 1,700 pounds per household per year. The utility believes that, in the absence of variable charges, rising incomes would have resulted in a growth in waste per household, although smaller household sizes also contributed to the downward trend.

A more marked reduction occurred with the tightening of monitoring at curbside (i.e. better enforcement of charge rates) and with the introduction of curbside recycling, which both were introduced in January 1989. Total waste collections have fallen by roughly 30% since these two measures were introduced.

However, it is not possible to ascertain whether it was the system of charges or the introduction of the recycling program that promoted this reduction in wastes going to

landfills. The evidence is somewhat mixed on this issue. According to the Seattle Solid Waste Utility, about 83% of households in Seattle participate in the blue box program. This participation rate compares with one of approximately 80% in Toronto where no incentive is offered to participate, which suggests that the participation of single family households might have reached its current level in Seattle without the program.[67] However, in terms of waste volume, there may be a more intensive use of blue-boxes by participants. High Bridge, New Jersey, which operates a similar pay-per bag program, found a 25% reduction in trash collections and an increased use of *existing* recycling programs (Anderson et al 1989).

The pay per bag program in Perkasie, Pennsylvania led to a 59% reduction in waste generation, with the majority attributable to household separation for recycling.

There is also evidence that communities with lower charge rates have not achieved the same total volume of waste reduction, which may indicate that the variable charge rates are an important factor in promoting waste reduction and recycling. Woodstock, Illinois, which has low tipping fees for wastes and passes these on in pay-per-bag charges that are less than half of those in High Bridge or Seattle, found only a 4-8% reduction through the use of variable charges in 1988. (Anderson et al 1989).

ii) efficiency in resource allocation by polluters

The policy encourages households and multi-residential building managers to reduce the amount of solid waste generated. The program offers an important economic efficiency advantage relative to a command and control approach that directly legislated a limit on garbage that could be collected from each household since charges allow households with the lowest costs of abatement to respond most aggressively in terms of waste reduction or recycling. Here abatement costs would include the value of the household's time in separating waste for recycling, more careful shopping and so on.

[67]Metro Toronto reports that a lack of cooperation from landlords with the blue box program has made participation in the apartment building segment much lower than that of single family dwellings. Landlords and superintendents feel that the program creates extra work for them. It is possible that a system of charges on garbage from apartment buildings could result in higher participation from this group.

Households will undertake waste reduction efforts as long as the costs to the resident of per unit of waste reduced are below the charge rate. If this charge rate is set at the total social cost of disposal, then the level of waste reduction will also be "efficient" in the sense that additional reduction efforts would exceed their benefits. However, there has been no effort in Seattle, or any other community we have examined, to ensure that the rates do indeed cover some of the non-cash costs of waste management, which suggests that overall abatement efforts are probably still less-than-optimal.

iii) system adaptability

Since its introduction the program has undergone several basic changes, the most important of which include:

- introduction of the 19 gallon can size to accommodate those households with smaller amounts of garbage;
- delivery of uniform, coloured cans by the solid waste contractor to each household in order to standardize the program and make garbage can size identification simpler; and
- rate increases.

These changes have been introduced in order to improve the effectiveness of the program and reflect the ability of regulators to make adjustments as needed in a period of increasing concern over solid waste management. As discussed above, the most recent changes, including the introduction of curbside recycling, have had a notable impact on garbage collection volumes.

iv) capacity to generate technological innovation

We have no evidence or information which would suggest that any technological innovation has been generated as a result of the program. We would expect that the use of composting technology might increase, although this would most likely be existing technology and not something developed as a result of the program.

v) capacity to induce research and development

We have no evidence that households are engaging in research and development activity as a result of the program, nor would we expect to find any given the emphasis on individual household response.

vi) requirements for cost of and frequency of monitoring, enforcement and administrative activities

Illegal dumping of garbage has increased as a result of the program, although the Seattle Solid Waste Authority believes that this is a relatively small problem compared with the overall benefit of the program. The city sifts through abandoned garbage for clues to the identity of the owner and fines are levied against those who are identified. In order to discourage people from illegal dumping the city has posted signs at the more common dump sites warning violators that they will be prosecuted.[68]

In addition to dumping garbage in abandoned lots, people deliver more used goods to charities which they might have previously put in the garbage, i.e. old furniture, clothing etc. As a result, charities are required to dispose of this waste if it has no value. The city charges a lower fee to charities to reflect this problem.

The contractor for the program is paid on the basis of the tonnage which is picked up and the number of households for which garbage is collected. As a result, there is an incentive for drivers to pick up more garbage from a household than is allowed under the program in order to increase tonnages and revenues for the contractor. Program administrators also believe that workers for the contractor are likely to accept small bribes from residents to pick up more than is allowed under the program. There is no enforcement mechanism in the contract to regulate the contractor or those picking up the garbage.

The Solid Waste Authority has added customer service representatives to answer questions from the public about the solid waste program.

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[68]Illegal dumping has also been a problem in the Perkasie, Pennsylvania program, where some businesses have had to lock their dumpsters to prevent their use by households, and other residents have been found to be violating regulations by burning trash in fireplaces.

In Perkasie, Pennsylvania, the introduction of a pay-per-bag system and curbside pickup of products for recycling added 18% to worker hours for loading separated and unseparated wastes (from an average of 2273 over 1985-87 to 2781 in 1988). In addition, there was a one time capital cost for truck modifications, recycling buckets and other equipment of $25,000. These additional costs were well covered by the returns to the city in reduced tipping charges and revenues from the sale of aluminum cans and paper.

vii) public, private sector and interest group perception

The Seattle Solid Waste Authority has not formally evaluated public opinion on the program, but their perception is that the public has accepted the program well. Seattle has charged residents a flat fee for garbage pickup since 1961 and, as a result, residents were accustomed to receiving a monthly bill for garbage pickup. The program which was introduced in 1970 was therefore not a new charge, but an adjustment to an existing fee for service. We would expect that household resistance to the program would be lower in this case compared to a situation where households perceived that they were being charged for this service for the first time. According to the Solid Waste Utility, environmental interest groups in the Seattle area are strong supporters of the program.

Evidence from across the United States suggests that the general public is not strongly opposed to charges designed to reduce waste generation. A poll found that 41% of Americans favoured taxes on difficult-to-recycle packaging materials and 96% are willing to pay surcharges on products for the purposes of reducing environmental harms.[69]

viii) suitability and effectiveness as public financing mechanisms

The Seattle Solid Waste Utility is an "enterprise agency" which requires it to operate without public funding. The revenue generated by the program provides for all of the expenses related to solid waste handling and management in Seattle including fees to the contractor, landfill site management, and program administration. The Utility did experience some variation in revenues in the early years of the program as a result of households reducing their solid waste or taking other measures to reduce the fees paid to the program.

[69] As reported in Ecology Law Quarterly, Vol 17. p 715.

The variable rate program used in Seattle offers a number of important advantage over fixed per household charges (or, as the case in most Ontario communities, property taxes) as a means of raising revenue for the management of solid household wastes.

First, as already noted, the program provides a built-in incentive for waste reduction and recycling.

Second, in contrast to other programs using charges examined in this report, the program takes into account the ability of polluters to pay by providing discounted pricing structures for low income earners, the elderly, and handicapped persons. In addition, since low income individuals are likely to place a lower value on their own time, they may be more inclined to take active steps to minimize their charges for trash pickup.

Third, the program is consistent with the polluter-pay principle. Part of the amount paid by any municipality for solid waste management is based upon the total amount of solid waste handled by the solid waste contractor. As solid waste is reduced, the municipality's cost declines. In this program, these savings are passed on directly to those who are responsible for reducing solid waste who are then able to use the money saved for other purposes, while those who use the waste collection system most intensively must pay for the costs of doing so. In traditional solid waste management programs, such as that in Toronto, any savings from a reduction in solid waste management costs would be passed along to all households in proportion to their property tax assessment.

The waste reductions in Perkasie Pennsylvania represented a $90,000 saving in direct disposal costs at the 1988 tipping fee rate of $59 per ton. The town also earned over $15,000 from the sale of aluminum (cans) and paper collected from recycling pick-up. Total costs to households declined by 40%.

ix) implications for international trade competitiveness

This program has no significant impact on international trade competitiveness.

4. ECONOMIC INSTRUMENTS IN OTHER POLICY FIELDS

4.1 Examples of Economic Instruments in Ontario and Canada

The economic instrument approaches reviewed in this report, while quite novel in terms of their use in environmental policy, are in fact well established tools of public policy in other fields. Thus, although Ontario's potential use of economic instruments might be pathbreaking in particular environmental applications, the province would not be employing policy mechanisms with which they lack experience.

For the most part, the use of economic instruments for non-environmental purposes has involved the use of pricing instruments – imposing higher or lower tax rates or charges on certain products or investments in order to increase or decrease demand. Such "tax expenditures" or supplementary taxes and fees have been widely used by all levels of government in Canada. Among the examples of taxes or charges used as incentives are:[70]

- The so-called "sin taxes" on tobacco products and alcoholic beverages, which play a dual role in raising revenues and, as acknowledged in the case of tobacco, in restraining consumption;
- Federal and provincial taxes on gasoline, fuel-inefficient vehicles and car air conditioners, although imposed principally as a revenue measure, also promote resource conservation (as well as protecting the environment by reducing driving and thus automobile emissions);
- tax penalties (in the form of a denial of a deduction) for advertising in foreign media;
- the requirement to capitalize carrying charges for land inventories, used as a means of controlling speculation;
- the various taxes imposed under the National Energy Program as an integral part of regulating this sector;
- Stumpage fees for forestry that are in part used to promote improved resource management;
- Tax concessions for investment in research and development;
- Income tax reductions for children offered by Quebec as part of their policies to stimulate population growth;

[70]This listing is based in part on Poddar (1991).

- Rates for worker's compensation which are in part based on claims made against a particular company, thereby providing an incentive towards workplace safety.

Quantity-based measures, such as marketable permits have also been employed in non-environmental policy fields. Marketable permits are used to control overall quantities while permitting some flexibility in resource allocation in the following areas:

- Farm quotas allocated under supply management programs for dairy and poultry products are marketable among farms, although more recent changes in milk marketing have restricted such sales to half of the quota (with the remainder being surrendered to the marketing board for re-sale).

- Taxi licenses are used by municipalities to restrict the total number of such vehicles. These licenses can be bought and sold at a purchase price that reflects the monopoly power associated with operating in a market with quantity and price restraints;

- Mining and timber cutting rights are also tradeable, although Ministerial approval is required in the case of the latter. To some extent, these are less analogous to environmental permit systems, since they are used to allocate a necessarily fixed supply (of land) rather than to restrain the level of activity over what might otherwise take place.

The two applications discussed below, taxes on tobacco products and marketable permits for milk producers, provide some additional insight into the utility of market-based approaches to environmental policies. They demonstrate how taxes can indeed alter individual behaviour, and how marketable permit systems promote efficiency in production by enabling firms with lower production costs to acquire rights from others.

4.2 Taxes on Tobacco Products

Canadian federal and provincial governments place particularly heavy taxes on tobacco products. These taxes serve five purposes, each of which closely parallels the objectives of taxes used for environmental protection:

1. they discourage the consumption of tobacco products in a manner than avoids the need for extensive regulations, quotas or other more costly policy mechanisms;

2. they raise revenues that help fund the health care costs associated with smoking;

3. they raise revenues for governments in a manner that meets with less political resistance than other taxes;

4. they enable governments to have lower tax burdens on other activities (savings, labour income, investment and capital income) which tend to reduce economic output and efficiency; and

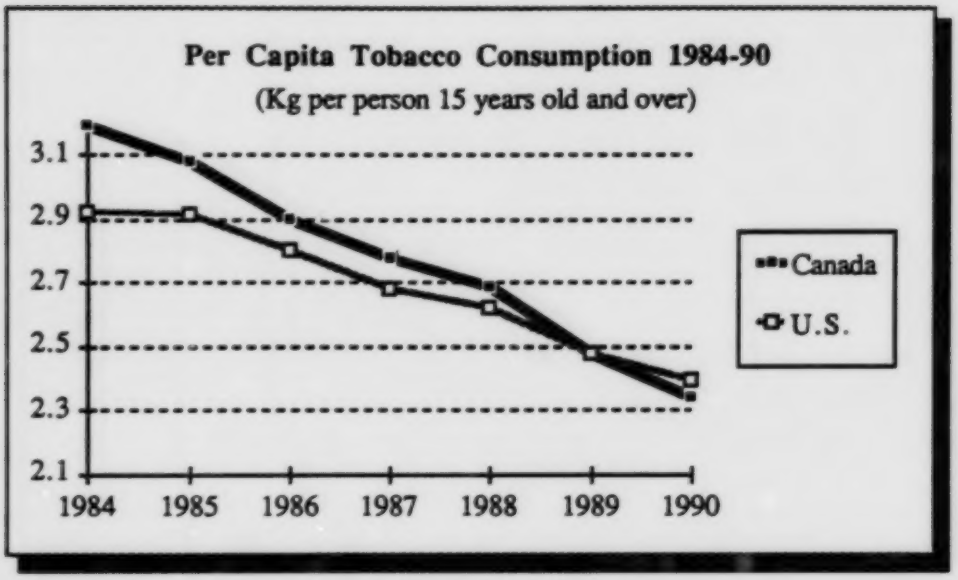
5. to the extent that second-hand tobacco smoke imposes costs on others, the tax represents an application of the polluter pay principle.

Canadian federal and provincial taxes on cigarettes and other tobacco products now result in Canada having the third highest prices for such products in the world. The rapid escalation of these taxes in recent years has had a marked effect on tobacco product consumption in Canada, as is demonstrated by Figure 4.1. Canadian consumption of tobacco fallen at a more rapid pace than American consumption, during a period in which tobacco tax increases in Canada have significantly exceeded those in the U.S. A formal study of the price response estimated that each 10% increase in prices reduces consumption by 4-14%, depending on the age group, with the greatest impacts on the young.[71]

Young people, some of whom would be in violation of laws restricting the sale of tobacco to minors, find the price barrier particularly onerous due to their low disposable income. Thus, the high taxes on tobacco products also serve to help enforce the command and control regulations on the sale of tobacco to minors.

[71] Department of Finance, *1991-92 Budget*

Figure 4.1



Source: Department of Finance (1990 figures are estimates)

As in many of the environmental applications of taxes or charges, taxes on cigarette consumption are a supplement to a number of command-and-control approaches to restraining consumption, which have also been tightened in recent years. These include labelling requirements designed to inform consumers of the risks of smoking, municipal restrictions on smoking in public places, and advertising bans. However, in contrast to some of the environmental applications, taxes are generally viewed by the industry as being the most important public-policy contributor to declining demand.

Direct regulation to restrict demand, short of an outright ban on production of tobacco products, would be a much more costly policy approach than the use of 'sin taxes'. Quotas on smoking by each person, for example, would require the government to issue and monitor the use of millions of such permits. Placing a restraint on total production and imports would emulate taxes to a certain extent by pushing prices up due to short supply, but the resulting windfall gains would flow to cigarette firms or tobacco growers rather than the government.

4.3 Marketable Milk Production Quotas

Quantity-based instruments, such as marketable effluent permits, are used in environmental policy as a means of distributing reductions in discharges in a manner that minimizes the total cost of achieving any given level of abatement. Marketable permits have also been applied in other fields of public policy to enable the market mechanism to allocate efficiently a fixed quantity of output. In the case of goods production, quotas that are marketable ensure that the total, fixed quantity of output is produced by firms with the lowest production costs.

Canada's dairy policies restrict the total volume of milk production in each province. Milk production quota trading provides an illustration of how tradeable permits have resulted in improved efficiency for the dairy industry, relative to a policy that allocated permanent quotas for each farm. Note that we focus only on the differential impact relative to such a fixed quota system, rather than on the impacts of supply management as a whole as compared to a free-market system for milk.

Milk quotas or production permits are tradeable between dairy farms and, in fact, an active market has existed ever since the system was introduced. Through quota trading, more efficient producers have been able to increase their share of milk production in Ontario, resulting in higher average milk production per cow, per farmer and per hectare of arable land. At the same time, the quotas enable the government to retain control over the total quantity of milk production in accordance with its supply management objectives.

The original quota limits were allocated in the 1960's, based upon each farmer's historical production records. When the program was introduced, farmers were allowed to freely trade quota and a market readily developed.

As demand for available quota increased beyond supply, the price of quota rose dramatically. In order to obtain quota for use by farmers that could not afford the market price, the OMMB established a system where any milk producer who sold his quota to another producer had to give an equal amount of quota to the OMMB. For example, if a producer who owned 1,000 kilograms of milk quota sold 200 kilograms to another producer, he would have to give the OMMB 200 kilograms as well, leaving him with 600 kilograms of quota. The OMMB quota is placed in a pool where it is sold to producers at a set rate on a first come-first serve basis.

Although any producer can be placed on a waiting list for quota from the OMMB, it appears that most of the quota is purchased by more efficient producers. There are several reasons for believing this to be the case, including:

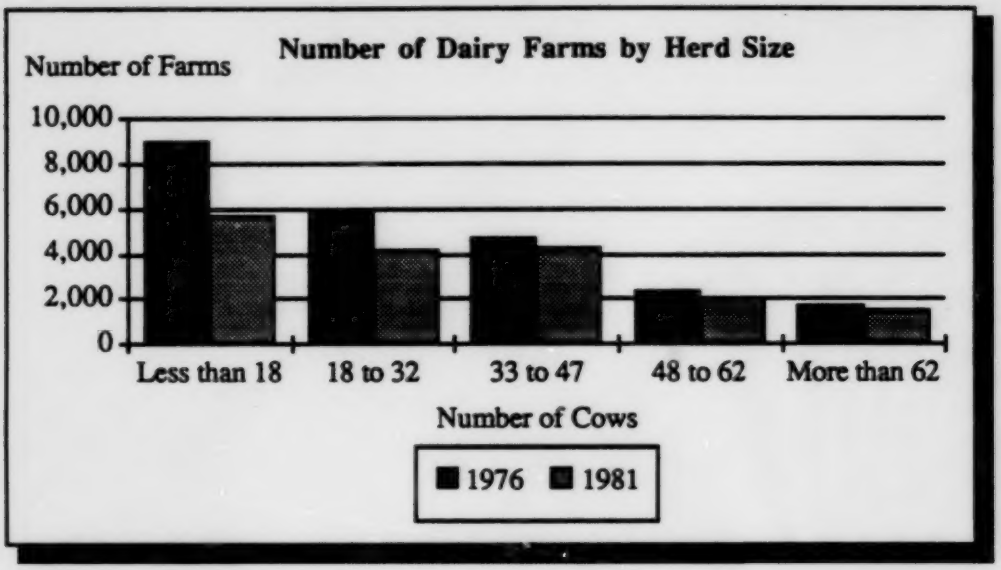
- a producer must be capable of meeting his or her quota production and must be able to increase production if new quota is purchased. Therefore, only those producers who had reasonable expectations of being able to increase their production, i.e. efficient producers, would be in a position to buy quota.
- the purchase of both new quota and the means to increase production to meet these new quota levels would require financing from a financial institution. It is more likely that efficient producers would be able to raise this financing.

Permit trading has been instrumental in encouraging an increase in average scale of Ontario dairy farms. The number of milk producers in Ontario (farms claiming to have cattle mainly for dairy purposes) has decreased from 23,628 in 1976 to 17,637 in 1981 and 14,025 in 1986, according to Statistics Canada. At the same time, total milk production has remained at or near the same level, suggesting that smaller farms (in terms of milk production per farm) have been more prominent among those leaving the industry.

This increase in milk production per farm has also been mirrored in an increase in average herd sizes. As Figure 4.2 illustrates, most of the decline in numbers between 1976 and 1981 has been among smaller producers, i.e. those with fewer than 18 milking cows.[72] By comparison, there was a relatively small decline in the number of farmers with a herd size greater than 33 milking cows during those years. As a result of smaller farmers leaving the dairy industry, the average herd size in Ontario increased from 27 cows in 1976 to 34 cows in 1986.

[72]Details on herd sizes were not provided in the 1986 census; 1981 is the most recent year available for these data, although average herd size can be calculated from the totals available for 1986.

Figure 4.2



Source: Statistics Canada, Census of Agriculture, 1976 and 1981.

Although data on the direct relationship between farm scale and production costs are not readily available, indirect observations of this linkage suggest that larger scale farms (in terms of both herd sizes and milk output per farm) has contributed, along with other factors, to greater efficiency in dairy farming.

First, as shown in Table 4.1, the largest farms (in terms of total net income) produce a higher average amount of milk per cow, per unit of labour and per hectare of land. These data are measured for a sample of Ontario dairy farms each year by the Ontario Dairy Farm Accounting Project which is a cooperative venture of the Ontario Milk Marketing Board, Agriculture Canada, the Canadian Dairy Commission, the University of Guelph, and the Ontario Ministry of Agriculture and Food.

Table 4.1

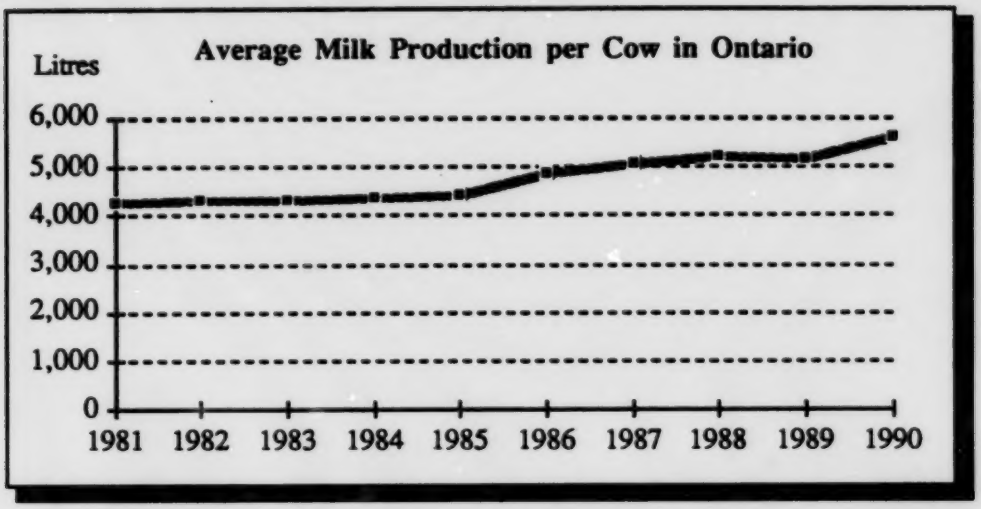
Comparison of Farm Production (average per farm)

	Low Third	Top Third
Milk Sold (litres)	194,909	330,242
Milk Sold per Cow(litres)	5,368	6,486
Person-Equivalents of Labour	1.8	2.1
Milk Sold/Person (litres)*	108,283	157,258
Workable Land Farmed (ha)	75	101
Milk Sold per Hectare (litres)*	2,599	3,270

Source: Ontario Dairy Farm Accounting Project, Extension Report, 1989, Agriculture Canada, the Ontario Milk Marketing Board, Ontario Ministry of Agriculture and Food, University of Guelph.
* Calculated by Ernst & Young.

Second, concurrent with the increase in average herd sizes, the average milk production per cow in Ontario has also been increasing, reflecting both better breeding and technology improvements that might have taken place in the absence of scale increases, as well as superior nutrition and other practices at larger farms. Average milk production per cow has increased from just over 4,000 litres per cow in 1981 to almost 6,000 litres per cow in 1989, as shown in Figure 4.3. Table 4.1 also demonstrates that farms with higher milk production per cow also tend to be those that require lower labour and land inputs per unit of milk produced.

Figure 4.3



Source: 1989 Agricultural Statistics for Ontario, Ontario Ministry of Agriculture and Food, August, 1990.

Thus, the trading of quota allocations has been associated with an increase in the average scale of dairy farms in Ontario, and one can link (although less conclusively given the impact of other factors in the same time period) this increase in scale to improvements in operating efficiency.

In the absence of trading, the supply management system that regulates milk production and prices would have permitted many small, inefficient producers to remain in the industry and be marginally profitable. Since the value of the quota to a large producer is higher than it is to a small producer, large producers have been willing to pay a price for the quota that is sufficiently high to induce small producers to sell their quota.

In recent periods, quota sellers must surrender an equal amount of quota to the marketing board. There are undoubtedly unrealized potential gains from trade as a result of this restriction, since, in effect, a buyer must value quota at twice the value as the seller in order for a trade to take place.[73] Similar unrealized trading opportunities occur when

[73]For example, in this environment, a seller of, say 1,000 units of quota who values these at $100 cannot profitably trade with a potential buyer who values them at $150. The trading restriction implies that the seller would give up all of his units, but will be able to *sell* only 500 (the remainder being ceded to the

restraints are placed on the trading of emissions permits, such as requiring more than offsetting reductions in emissions by the seller.

marketing board). He requires $100 to be willing to give up all his units, but the purchaser, obtaining only 500 units, would pay at most $75 (half of $150).

5. GENERAL FINDINGS ON THE USE AND PERFORMANCE OF PRICE INSTRUMENTS IN ENVIRONMENTAL PROTECTION

5.1 Introduction

The case study evidence reported in Chapter 3, as well as numerous other examples examined by the study team but not discussed here in the interest of brevity,[74] demonstrate that both economic instruments and command and control regulations have generated a mixture of successes and failures when evaluated on a broad range of criteria. Thus, for future policy decisions, the types of approaches that should be adopted will depend upon the relative importance assigned to various policy objectives and the nature of the environmental problem being addressed.

In Chapters 5 and 6, we conduct a more general review of price and quantity-based economic instruments respectively, reviewing the extent of their international application, assessing their effectiveness, and comparing their merits and demerits relative to the traditional command and control option. Our focus is on identifying the types of conditions conducive to stronger or weaker performance on each of the evaluation criteria used.

5.2 Applications of Price Instruments to Environmental Protection

5.2.1 Introduction

As shown in our case studies, taxes, charges and other price instruments can be employed both as supplements to command and control regulations or as the primary instrument of environmental policy. They offer the potential for environmental benefits by creating an economic incentive for abatement efforts or for reduced consumption of environmentally damaging goods, and, in the case of charges, by raising dedicated revenues for environmental management projects and operations.

While not as pervasive as command and control programs, price mechanisms have seen wide application in environmental protection, and are currently under extensive study by governments in Canada, the U.S. and Europe. The following is a sample of such current or proposed applications.

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[74]For additional cases, see Opschoor and Vos (1989), Anderson et al (1989) and Hahn (1989).

5.2.2 Effluent / emission charges or taxes

Effluent or emissions charges and taxes are those linked directly to the discharge of a contaminant into the environment. Systems in operation include charges for water pollution control or sewer surcharges in France, Germany, Italy, Canada, the Netherlands; air pollution charges in France; aircraft noise charges in the U.S., Japan and several European countries, and charges on solid wastes in the U.S. and a number of European countries.[75] Taxes or charges have been proposed or are in the process of implementation for: sulphur, carbon and nitrous oxide emissions in Sweden; for certain solid wastes in Denmark; for SO_2 and industrial waste in Italy; and for carbon dioxides in the Netherlands.[76] In the vast majority of applications, effluent or emissions taxes are used as a supplement to command and control standards, rather than as the sole mechanism for environmental management.

5.2.3 Product charges

Closely related to emissions or effluent charges are "product charges", which are special excise taxes on the consumption or production of a particular product whose production or use is linked to environmental damage. These differ from emissions or effluent charges in that it is the consumption or production of the product, rather than an actual emission *per se*, that is the basis of the charge. In some cases, the policy is implemented through "tax differentiation", imposing higher taxes on environmentally-damaging products (e.g. leaded gasoline) relative to less-harmful substitutes (e.g. unleaded gasoline). The charges can be imposed at either the consumer level or the industry level. They tend to be used far more frequently than effluent or emissions charges as the prime instrument of environmental management, rather than as a supplement to command and control.

Product charges are perhaps the most widely used economic instrument in the environmental field.[77] European countries have made wide use of such charges, applying them on the production or consumption of such products as lubricants, batteries, mineral

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[75]Opschoor and Vos (1989)

[76]The Economist (1990)

[77]See Stone (1990) for an extensive listing of these charges worldwide.

oil, air travel, plastic bags, livestock fodder, fertilizers, CFCs, food and beverage containers, and pesticides. Canadian jurisdictions have applied charges on leaded gasoline, tires, beverage containers, high energy-consuming vehicles, and oil shipping. U.S. charges include those placed on the consumption of fuel-inefficient vehicles, littered items, beverage containers, batteries, tires, newsprint, solvents, containers, lubricants and solvents, and on the production of oil, chemicals, coal, CFCs and Halons. Both North American and European jurisdictions are studying the potential use of taxes on the consumption of carbonaceous fuels as a means of addressing the greenhouse effect.

5.2.4 Deposit-Refund Systems

Deposit-refund systems differ from other charges in that the individual paying the charge can have it rebated by undertaking an environmentally-beneficial action.[78] Beverage container deposits systems are in use in Europe, Canada, the U.S., and Australia. with refunds provided upon the return of the container which is then either recycled or re-used. Other examples include deposit-refund systems designed to encourage proper disposal of car hulks (in Sweden and Norway), and lead-acid batteries (in several U.S. states). European jurisdictions are considering new deposit-refund systems for batteries or large appliances. They can be accompanied by command and control measures (e.g. anti-littering laws) in some cases.

Ontario's "financial assurance program" is in effect a deposit-refund system.[79] Under this program, the Ministry of the Environment can, at its discretion, require a regulated firm (most frequently a waste management company) to provide letters of credit or cash deposits in a trust fund held by the Ministry until the completion of tasks specified in control orders. Failing such completion, the Ministry can use the funds provided to finance appropriate compliance measures.

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[78]While charges raise funds for a dedicated environmental purpose, often serving the industry or households subject to the charge, the expenditures or funds are not targetted at precisely the same firms or households paying the charge. A deposit-refund system enables each firm or household paying the charge to recoup the deposit actually paid by that individual firm or houshold

[79]The provision of financial assurance is authorized under Part X-A of the Ontario Environmental Protection Act (enacted in 1986). See Donnan et al (1987).

5.2.5 Other Price Instruments

Two other classes of price instruments are also used for environmental purposes, generally as supplements to other instruments rather than the primary mechanism for protecting the environment. **Subsidies** toward pollution abatement activities operate much in the same way as taxes. Rather than *increasing* the cost of failing to abate, subsidies *reduce* the cost of abatement in terms of the costs borne by the firm or municipality receiving the subsidy. Note however, that subsidies leave the total economic cost of abatement unchanged, but merely shift the burden of paying for them.

Subsidies for environmental protection, in the form of grants, low interest loans or tax concessions, are widely used internationally, particularly in Europe. Opschoor and Vos (1989) found that on average, OECD countries pay for 5-20% of environmental protection costs through such programs. Canadian examples include tax concessions as well as grants to municipalities. Canada's generous write-offs for pollution control equipment were found by Hickling (1990) to be a significant competitive advantage for companies purchasing such equipment.

A second price mechanism operative in virtually all countries through the imposition of **legal liability** for damage done by a polluting firm. This in effect increases the cost of noncompliance with environmental laws or causing damage to the health and property of others. In Ontario, firms can be prosecuted by those subject to damage under nuisance laws, and liability has been extended to creditors and receivers in the event of bankruptcy.

In the U.S., the right to sue on environmental grounds has been extended to disinterested parties, through the application of what has been termed the "public trust doctrine". Individual states have passed laws granting individuals the right to sue to protect the natural environment, and federal environmental laws in the U.S. permit citizen suit enforcement of environmental statutes. Ontario is currently considering an expanded role for private citizens in developing environmental standards and in protecting the environment through the courts.

5.3 Effectiveness of Price Mechanisms

In this section, we evaluate the strengths and weaknesses of environmental charges and taxes relative to command and control instruments on the same criteria used in our case studies. The conclusions in this section draw upon the case studies of Chapter 3, along

with other examples reviewed in the literature, including those examined in Opschoor and Vos (1989), Stone (1990) and Hahn (1989). We cover both their performance as primary instruments and as supplements to command and control measures.

5.3.1 Capacity to protect and improve environmental quality

Taxes, charges and deposits have had a mixed performance in terms of their ability to generate substantial improvements in environmental quality relative to the types of gains seen with command and control approaches. As we discuss in this section, price mechanisms have been most successful in generating abatement activity where:

- governments have been willing to impose sufficiently high rates of taxes, charges or deposit requirements; and
- the relevant demand, supply or marginal abatement cost conditions are such that behaviour is price sensitive.

From an environmental perspective, the use of price instruments as the major instrument of environmental management is more appropriate where:

- the discharges being controlled are not highly lethal at low levels;
- the environmental medium into which discharges occur is well-mixed, and not subject to strong local pollution effects; and
- the damage created by discharges is not subject to major threshold effects.

Where these conditions are not met, price instruments can still offer an effective supplement to command and control, by providing a financial incentive to meet or exceed command and control standards.

The case studies provided a number of examples where taxes or charges have had a demonstrable impact on environmental quality. For example, variable charges for household waste collections and water effluent charges in the Netherlands, have been shown to be significant contributors to environmental goals. Deposit-refund systems have been very effective in promoting the re-use of beer bottles and cans in Ontario, and have worked well for car hulks in Europe.

However, in most of the applications we have reviewed, pollution taxes have had only modest impacts on environmental quality. Several of the water charge examples as well as some solid waste taxes were too low to generate incentives for abatement. Other

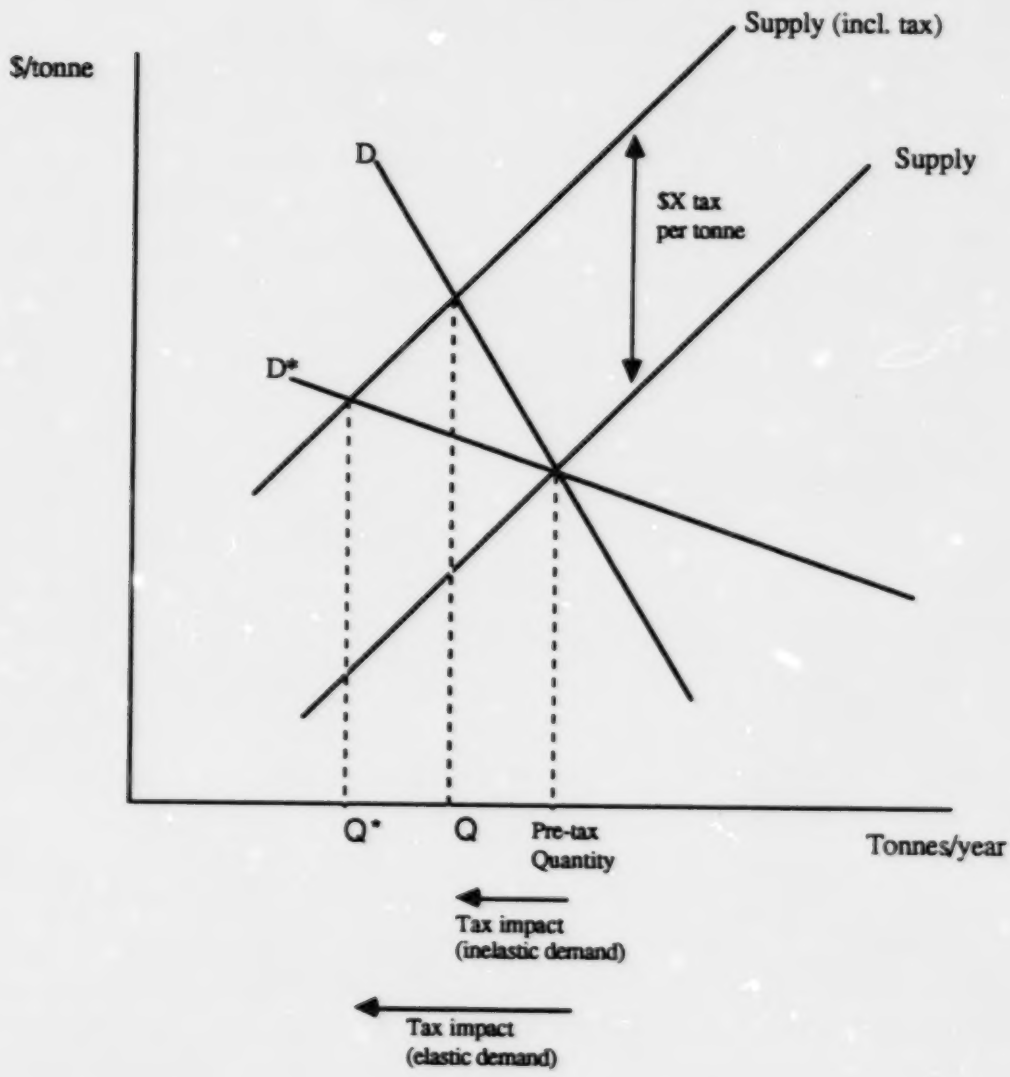
examples where price instruments have been found to have not significantly promoted environmental protection are litterable product taxes in the U.S. and tire taxes in various North American jurisdictions.

In practice, the degree of response to a charge, tax, or deposit-refund system is linked to (1) the elasticity of the relevant demand or supply function (the percentage change in behaviour attributable to a given percentage change in the effective price) and (2) the rate of tax applied. In the following, we review the determinants of each of these overall factors.

Factors Affecting the Elasticities

A given tax, charge or deposit rate will result in a greater impact if consumer or business behaviour is more "sensitive" or "elastic" with respect to the effective price changes implied by the policy. For example, Figure 5.1 shows the change in demand for a product upon which a charge has been imposed for environmental purposes (e.g. a tax placed on fuel designed to reduce its use and the resulting CO_2 emissions). As shown in the Figure, the steeper demand curve D, which is less elastic at the pre-tax quantity, shows a smaller response to the tax than the same tax imposed on a product whose demand is D*.

Figure 5.1
Response to a Product Tax or Charge



Thus, in the case of ***product taxes*** on environmentally-damaging goods, the environmental benefit (i.e. the decline in usage) will be smaller if demand is highly inelastic.[80] This is likely to be true under the following circumstances:

[80]This does not imply, however, that "green taxes" should not be imposed on goods or services with inelastic demands for other policy reasons. As we discuss below, there are tax-policy advantages to such taxes even where the environmental response is negligible.

- *close substitutes are not available.* For example, in the case of auto tires, where the closest alternative is to eschew driving altogether (or run a vehicle on old, unsafe tires), demand is likely to be highly inelastic. In contrast, taxing leaded gasoline, where unleaded fuel is a close alternative for most cars, is likely to induce a significant response.

- *the tax is on a narrowly defined set of commodities.* The broader the group of goods being taxed (i.e. taxing all paper products vs. only bleached paper), the more distant the substitutes are likely to be. A broadly-based one cent per pound tax on all carbon emissions in the U.S., for example, would yield some $30 billion annually, but cause only a slight impact on carbon dioxide production.[81] "Essentials" tend to face less elastic demand. A greater response will be generated if the tax is accompanied by a reduction in sales taxes on "green alternatives", as is the case in some tax differentiation proposals.

- *the impact is being measured over a longer time period.* Elasticities vary over time. Long-run elasticities will be greater than in short-run elasticities, since consumers and producers are more able to develop and shift to substitutes over time. For example, a tax on gasoline will induce some conservation in the short-run due to adjustments to driving behaviour. Much greater conservation impacts are possible in the long run, as consumers purchase more fuel-efficient cars, or move closer to their place of work.

- *the tax is on a low cost item, particularly where the item is part of a much larger purchasing decision.* In the purchase of a car, for example, an additional cost associated with a tax on tires will have a small impact on the overall vehicle cost and will therefore have minimal impact on car (and thus original-equipment tire) purchasing decisions. A similar rate of tax on the vehicle as a whole would make a car (or a second car) unaffordable for some purchasers, and would therefore face a more elastic demand.

In the case of a ***tax or charge on a business input*** (e.g. chlorine for paper bleaching, for example), similar factors will affect the elasticity of demand for the input. Where there are few close substitutes, or where the input is a minor one in terms of its share of total production costs, a given percentage tax on the input will induce a smaller change in usage. For example, a tax placed on the use of CFCs will have a greater impact for uses where other un-taxed chemicals are close substitutes.

The substitution response may be discontinuous for both consumer and business input tax. The elasticity may be zero for a low rate of tax, if the taxed product remains cheaper and more effective than a substitute for all users, and then be infinite (i.e. lead to

[81] Anderson et al (1989)

complete substitution) for tax rates that push the effective cost above a near substitute. For example, in the case of the tax on leaded gasoline, it was critical that the tax be sufficiently high to push the price of leaded gasoline above the unleaded alternative. Where consumers have non-price preferences, such as between disposable and cloth diapers, the aggregate response is likely to be more continuous, with a given tax inducing a switch only for those consumers who place the least value on the convenience of disposables.

For ***taxes or charges on discharges***, the elasticity of response (i.e. in terms of abatement efforts) is determined by the nature of the marginal costs of abatement. The lower are the marginal abatement costs, and the less these costs rise with additional abatement effort, the greater will be the environmental response to any given level of taxes or charges. Thus, where abatement can be achieved with a fairly modest cost or effort, a very small tax might induce a large response in discharges.

The elasticity of response to ***deposit-refund systems*** is similarly related to the marginal costs of abatement. In this case these costs are determined by the costs associated with the activity that generates a refund (e.g. the return of a bottle to a recycling pick-up point). These costs will be lower, for example, if bottle return locations are conveniently located. Beer bottle returns in Ontario have typically been high despite a fairly low deposit rate, because returns are made to beer stores by consumers as they make their next purchase.

Factors Affecting the Charge or Tax Rate

The rate of a tax, charge or deposit is the second key factor in determining its impact on the environment. Higher rates will induce a greater response by either consumers or industries in terms of abatement, consumption shifts or returns to collect deposits. This was apparent in comparing the impact of water discharge taxes in the European countries covered in our case studies.

In practice, taxes have been criticized and judged ineffective in promoting environmental protection primarily because governments have typically imposed taxes at rates that were too low to induce a major response by polluters. Daniel Dudek of the U.S. Environmental Defence Fund, a key proponent of marketable permit systems, argues that taxes should not be viewed as a potential substitute for quantity-based economic

instruments for this reason.[82] This criticism would be more aimed at the use of taxes as the major instrument in promoting abatement, rather than as a supplement to command and control.

According to tax policy officials in the Ministry of Treasury and Economics, there are no important legal restraints on the ability of the Province of Ontario to impose excise taxes in terms of the rates applied. However, in practice, political and competing economic considerations have influenced the rates of taxation imposed for environmental purposes.

This is particularly true in the case of effluent or emissions taxes, where, as seen in the case studies reported in this study and in other examples examined in Opschoor and Vos (1989), tax rates have often been far too low to have meaningful incentive effects.

In part, this is because they have not typically been viewed as the central mechanism for promoting abatement. Rather, most discharge taxes have been imposed in cases where command and control regulations were also operative. Hahn (1990) concluded that "the major motivation for implementing emission fees is to raise revenues, which are then usually earmarked for activities which promote environmental quality." Revenue-raising objectives can then conflict with environmental ones, since a tax or charge that encouraged near complete abatement would raise very little revenue. The most attractive items to tax for revenue purposes are those with low elasticities, where a high tax rate can be imposed with little resulting change in discharge volumes.

However, even where incentive effects were intended, the rates are often quite low. The opposition of industry to high effluent tax rates, in conjunction with what has been termed the "capture theory of regulation," may account for the resulting low rates. As we discuss in Section 5.3.7 in more detail, Buchanan and Tullock (1975) demonstrate that industry will prefer command and control standards over emission taxes. Where governments press ahead with emissions taxes, industries, as was the case in France, for example, will press for low rates of taxes. According to proponents of capture theories, interest groups subject to regulation are able, over time, to obtain significant influence over the regulators. Becker (1983) and other "Chicago School" economists maintain that relative interest group power is able to explain the resulting government decisions on matters such as taxation.

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[82]Personal communications with Danial Dudeck, U.S. Environmental Defence Fund, 1990.

Increasingly, however, the environmental movement has as much if not more influence over government decision making than the industries subject to regulation. Furthermore, the fact that governments in the past have failed to impose sufficiently high taxes to induce a reduction in emissions need not imply that this will continue to be the case. Finally, similar industry influences have in the past been effective in forestalling regulatory efforts under command and control programs.[83]

In order to reduce industry resistance to the higher rates necessary to promote abatement, Ontario could consider the use of charges or deposit systems, where the funds collected are rebated back to the industry (either for targetted environmental purposes or as rebates in the case of deposits). As we discuss below, these systems generate winners and losers in the group subject to the deposit or charge system, and thus a high rate would not be universally opposed by the regulated group. Furthermore, since governments do not retain the revenues raised in these systems, revenue-raising objectives will not come into conflict with environmental goals in setting the rates.

Other Considerations in Environmental Performance of Price Mechanisms

Price instruments may also fail to provide adequate protection for the environment even where firms or consumers are responsive to the tax or charge imposed. The protection can prove to be inadequate where even trace emissions have a high social cost (e.g. for extremely toxic substances), or where discharges from individual firms are not equivalent from an environmental perspective.

Price instruments such as taxes have not been used as the prime instrument of control for very toxic substances. In such cases, the environmental objectives typically are to achieve the lowest possible levels of emissions, or at least to minimize human exposures. The optimal tax rate on avoidable discharges would then be infinite, in effect, since one would not be willing to allow a firm to trade-off such discharges against a tax payment. The only potential uses for price instruments in such a context would be as an additional incentive for compliance under a command and control program, (in effect serving as an automatically imposed fine), or as an additional incentive as a part of a phase-out program for emissions.

[83]Donnan et al (1987) cite a number of such examples (p 4). Bonsor (1990) argues that industry resistance to costly abatement requirements forestalled successful environmental protection in the case of effluents from pulp and paper mills.

Further problems arise when the marginal damage per unit of discharge differs among the firms or households. This can result from differences in:

- the distance to affected plant, animal or human receptors;
- the dispersion properties of local atmospheric conditions, or local water bodies; or
- the composition of the discharges (e.g. specific VOCs or BOD elements).

In such cases, a single effluent or emissions tax will result in too little abatement by the source that is responsible for the greater environmental harm per unit of discharge.

Product charge may also be less-than-ideally linked to the source of environmental damage. British Columbia dropped a proposed hazardous products levy, which would have been imposed on all purchases of a wide range of chemicals, in favour of an increased waste discharge fee. The logic behind this shift was that the mere purchase of a chemical product was not well linked to the ultimate damage to the environment. Similarly, taxes on automotive fuels, while they do discourage driving, do not do so in a manner that differentiates among vehicles with differing emissions performance per litre of gasoline used.

Price instruments offer the potential for improvements over command and control policies as a result of their implications for enforcement. We discuss these in Section 5.3.6 below.

5.3.2 Efficiency in resource allocation by polluters

Taxes, charges and deposit systems have been found to offer significant economic efficiency advantages. Simulation results suggest that, in some cases, savings up to 80% of total abatement costs under command and control could be achieved. The advantages are linked to the flexibility of polluters in selecting abatement methods, the generation of greater abatement by firms with lower abatement costs, and the elimination of excess output by polluting industries that fail to incorporate pollution costs into their internal decisions.

In practice, threshold effects in pollution damage, non-mixed local environments, and regulators' uncertainty over marginal abatement and damage costs can pose difficulties in achieving the theoretically ideal result. Even so, there may be many potential

applications where price instruments will be favoured over command and control on efficiency grounds.

The Theoretical Ideal

Economists initially suggested taxes or charges as a means of environmental management principally due to the theoretical linkage between such systems and economic efficiency. Under ideal circumstances, an emissions or effluent tax satisfies two key conditions for efficiency:

1. *cost minimization* – each firm, and an industry as a whole, will achieve any given level of abatement in a manner that minimizes the total economic resources devoted to abatement; and

2. *optimal abatement* – where the tax rate on discharges is set equal to the marginal benefits of abatement[84]

In the extreme, where abatement at all sources achieves equivalent marginal benefits, a single rate of tax on discharges can be used to achieve these results.

Since this theoretical argument is well documented elsewhere,[85] we provide only a brief review of it here. Suppose a firm is faced with a tax of $100 per tonne of discharge, where $100 is the marginal damage done by an additional tonne of discharge. The firm will choose to undertake abatement efforts as long as the cost of reducing discharges is less than $100 per tonne. If abatement becomes increasingly expensive as emissions are reduced, there will be a unique level of discharges where the marginal cost of further abatement exactly equals $100 per tonne. This will be the level of discharge selected by the firm.

Since the firm is free to select its abatement approach (in contrast to a technology-based command and control system), the firm can select the cost-minimizing abatement technology. Furthermore, from a social perspective, additional abatement would not be desirable, since the cost of abatement would exceed the benefits in reduced damage to the environment.

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[84]These benefits would include the total economic value of reduced mortality and morbidity, reduced damange to plants (including crops) and wildlife, improved scenery and public enjoyment of a clean environment and so on. We discuss measurement problems below.

[85]See, for example, Baumol and Oates (1988).

If all firms are responding to the same rate of tax, then each firm will have reduced discharges to the point where the cost of further abatement equals $100 per tonne. There are therefore no possibilities for advantageous emissions trades among firms, a key condition for "efficient resource allocation". Each firm would pay *up to* $100 per tonne for the right to increase emissions (the cost of the last unit of abatement) and would require *at least* $100 per tonne to be willing to undertake additional abatement. The absence of mutually beneficial trades in turn implies that the total abatement effort has been achieved at the smallest total cost to the industry as a whole. This is in contrast to command and control systems, where (as we showed in the case of acid gas reduction in Ontario, for example) there are often large differences in marginal abatement costs at the levels of abatement required by the controls placed on individual firms.

Similar to the case for taxes, the use of charges or deposit-refund systems can also be shown to result in certain efficiencies in resource allocation. For deposit-refund systems, the deposit should be set at the marginal social cost of damage (e.g. the cost of an improperly discarded bottle, for example). Some argue that the funds raised by charges should be returned to the industry to subsidize abatement efforts. Since such a system alters both the cost of abatement to the firm as well as the penalties for failing to abate, the optimal charge should be lower than the optimal tax, or the system will generate "excess abatement" (i.e. reductions where the value of abatement is less than the cost of abatement from a social perspective).

Furthermore, where charges or deposits are returned to the industry, the result is a tendency for the industry to overproduce its output relative to an economic optimum. As Dewees (1990a) notes, pollution taxes not only encourage abatement, but also raise the costs and thus the price of the industry's product, which will tend to reduce the level of demand and thus output. This impact, absent in the case of charges or deposits refunded to the industry, is actually desirable in terms of achieving an efficient allocation of the economy's resources.[86] Prices charged to consumers (and thus the resulting level of production) should reflect not only abatement costs, but also the marginal cost of the

[86]Non-competitive industries, generally those with few firms and a lack of import competition, are a potential exception in this regard. Such industries have a tendency to underproduce their output (and charge higher prices) relative to an economic optimum. Since pollution taxes result in a further cutback in output, this could reduce economic efficiency (depending on whether the tendency to underproduce is more than offset by the tendency to overproduce due to the failure to internalize pollution costs).

environmental damage caused by the remaining emissions. This will be true under an emissions tax policy.

Overall, the potential efficiency gains from pollution taxes over a command and control approach designed to achieve the same total abatement can be substantial. Various studies cited by Dewees (1990a) found that the cost-minimizing abatement strategy would save 20% to 80% of the costs incurred in meeting command and control regulations. While these results were derived from U.S. regulations, our own review of command and control programs in Canada (see Chapter 3) showed significant differences in marginal abatement costs, and thus major opportunities for cost savings.

Efficiency Considerations in a Non-Ideal World

The typical environmental problem may not match the theoretical ideal in a number of ways. Several of the complexities entailed in "real-world" environmental problems can be shown to undermine the economic efficiency arguments for the use of taxes or other price instruments. However, these price instruments may still achieve efficiency gains relative to command and control.

One common difficulty arises when the medium into which the discharges occur differs among the firms subject to the tax, or is imperfectly mixed. For example, paper mills may be located on different bodies of water. The marginal cost to the environment caused by discharges from each mill will then differ depending on the properties of the bodies of water involved. As discussed in the previous section, in such cases, adequate protection for the environment could require a much cleaner performance by some firms relative to others. A single, uniform tax on all firms would then fail to achieve an optimal abatement effort, and a potentially complex set of taxes, differing for each firm or perhaps for each geographic zone, would be required to achieve both optimal abatement and cost-minimization.

While regulations in a command and control approach would also have to be applied on a case-by-case basis, the complexities introduced under imperfect mixing eliminate the advantages that pollution taxes otherwise have in terms of simplicity in design. Pollution taxes would retain some other advantages (used in isolation or as a supplement to command and control), such as providing incentives to exceed a target level of discharges and allowing flexibility in the means of response by firms.

Environmental problems subject to threshold effects (i.e. where damage is inconsequential below a certain level, then high above it), or where damage costs vary with climatic conditions or seasons, can also require more complex charge schemes.

Several studies, reviewed in Dewees (1990a) have attempted to estimate the performance of simple, uniform effluent taxes in non-perfectly mixed environments.[87] These estimate the costs of achieving a given ambient quality (e.g. air quality in a given region) under different types of policies. The results of these studies do not point to a common conclusion. Some studies found that imposing a single effluent charge, where a system of multiple charges would be required due to imperfect mixing, can have disastrous consequences for total abatement costs if the ambient air quality standard is pursued aggressively. Others found that charges still outperformed command and control systems.

Other problems of a practical nature can limit the ability of regulators to use emissions charges or taxes to achieve the desired level of abatement. In the absence of detailed knowledge of abatement costs, the regulator will be unable to predict the extent to which abatement levels will adjust to charge or tax rates. Repeated adjustments to these rates can impose high costs on firms that have designed systems to meet initial charge levels.

This suggests that taxes and other price instruments may be undesirable where there is considerable uncertainty regarding abatement costs and where abatement entails major capital spending plans that cannot be adjusted once in place. Either tradeable permits or command and control approaches would avoid these problems of uncertain response.

A lack of knowledge on marginal damage costs will also mean that the regulator will be unable to determine the "optimal" charge rate, although in practice, this is also true for a regulator seeking the appropriate tightness for a command and control or marketable permits policy.

In sum, while the various price mechanisms have strong efficiency advantages in some cases, these advantages can be eroded by complexities entailed in other applications. A careful review of the extent of mixing of the environment, the extent of threshold effects, and the degree to which effluents from different sources pose differing environmental

[87]The following section is based on Dewees (1990). Specific sources are cited therein.

costs, is necessary to determine whether efficiency gains through price instruments can be realized.

5.3.3 System adaptability and jurisdictional issues

One of the most common criticisms of command and control policies relates to the long timeframes required to make adjustments to regulations. This was frequently cited by environmental groups interviewed for this study as a problem with environmental management in Ontario.

Analysts who have examined the pollution tax alternative have reached differing conclusions on the extent to which they are more easily adjustable over time relative to command and control regulations. Brown and Johnson (1984) cite Kneese and Bower, who concluded that effluent charges are more readily adjusted. They contrast this finding with that of Baumol and Oates, who concluded that the *inability* of regulators to frequently adjust taxes was a "serious practical liability" for such systems. These differing views reflect a mix of factors that act in opposing directions in terms of the adaptability of pollution taxes.

In contrast to detailed controls on individual sources of pollution, environmental taxes and charges leave the complexities of abatement activity to the regulated firm, municipality or household. Thus, a potential advantage of charges is that, in the case of emissions into well-mixed media, they can be adjusted without a detailed review of the situation at individual sources of emissions, which could shorten the timeframe for regulatory change considerably. The effluent charges reviewed in Chapter 3 have seen their rates adjusted several times since their inception, typically to increase the rates in order to keep pace with inflation and to encourage additional abatement as it becomes technologically feasible.

A second advantage for emissions charges or taxes is that firms will *automatically* respond to changes in marginal abatement costs, even if the rate of the charge or tax is left unchanged. For example, if a new, low cost abatement technology emerges, firms could adopt the technology in order to reduce their liability for taxes or charges. This is in contrast with a command and control system, where regulators would have to recognize the existence of the new technology, and redraft control orders to compel its use by firms subject to regulations. However, neither price instruments nor command and control policies will induce an automatic adjustment to a change in marginal damage costs.

Other factors act to limit the adjustability of pollution taxes or charges. Where environmental taxes are used (as opposed to charges or deposit-refund systems), governments may begin to view these as important elements of their revenue base. This might be even more of a problem in the case of charges where the revenues are earmarked for an important environmental purpose, since the temptation would be to set the budget for expenditures and then set the charge to raise the required revenues (rather than to achieve a given level of environmental performance). This is the case, for example, in the method for setting water charges in France.

Traditionally, even those taxes applied with non-revenue objectives are under the control of the Treasury and Economics Ministry. The revenue objectives of the Treasury could potentially come into conflict with environmentally-required adjustments to discharge tax rates, if the appropriate rate for environmental purposes would result in a decline in overall revenue.[88] For this reason, Olewiler (1990) advised against too heavy reliance on environmental taxes as a revenue-raising mechanism.

The case study evidence does not provide much guidance on the extent to which the overlap in authority between environmental and fiscal policy makers would prove to be a problem in practice. For the most part, environmental taxes have been used as a supplement to command and control, and thus environmental authorities have retained the power to set minimum environmental performance standards as their major tool in environmental management. The rates of taxes have tended to be too low to be either a major environmental clean-up incentive or a significant revenue source to governments. In other cases, revenue-raising, rather than environmental incentives, was the clear purpose the tax from the outset.

Thus, should Ontario use taxes on discharges as a major instrument of environmental policy, it might be the first jurisdiction to face significant conflicts between environmental and revenue policies. If the tax is to be primarily aimed at environmental management, care would have to be taken in the design of the program to ensure that this remained the case over time. A cooperative approach between the Ministry of Treasury and Economics and the Ministry of the Environment could be used to address this requirement. The Ministry of the Environment, through its broad environmental mandate, could be

[88]Note that revenues could decline or increase with an increase in an effluent charge, depending on the extent to which a higher charge led to lower discharges.

charged with monitoring the effectiveness of environmental taxes and recommending adjustements to ensure that environmental objectives remain paramount. For example, the legislation could set targets for overall abatement that the tax is designed to achieve, and link adjustments in the rate of tax to the extent to which these are met, based on monitoring by the Ministry of the Environment.

Alternatively, as in many of the cases examined in the course of this study, discharge taxes could be used only as a supplement to command and control policies. This would allow the rate of tax to be set by the Treasurer, with the Ministry of the Environment continuing to impose minimum command and control standards on pollution sources. The tax would serve as an added incentive to meet or exceed environmental standards, rather than as the principal instrument of environmental policy.

A further problem with price instruments is the fact that they *require* more frequent adjustments than command and control policies. In particular, the level of the charge must be continually adjusted to keep pace with inflation. Otherwise, the incentive for pollution abatement will decrease over time (a problem not present with marketable permits or command and control methods). Doern (1990) argues that:

> Maintaining taxes at real rates of value can also be a problem. ... The temptation for finance ministers to impose many little, partially real, partially symbolic taxes to gain continuous credit for environmental initiatives may well be irresistible. One could then imagine pressure in 2000 for environmental tax reform to clean out and simplify the tax system, much as was said about other aspects of tax reform in the 1980s.

One approach to addressing this problem upfront is to incorporate inflation indexing into the design of the program, as is the case with some features of the income tax.

A final restraint on the use of pollution taxes by Ontario relates to the constitutional limits placed on the provincial government in the field of taxation. Under the *Constitution Act*, (originally the British North America Act) the province is limited to the use of "direct taxation" within its jurisdiction, and restrained from using "indirect taxes". To qualify as direct, the general tendency of the tax must be that it is borne directly on consumers and users of the product, rather than passed-on upon resale of the product. Businesses can be taxed by a province as consumers of a product (e.g. fuels purchased for their own use), but not as re-sellers (e.g. a tax on purchases of natural gas by local gas distributors).

The need to tax the consumer would add to the administrative complexities of some "green taxes" at the provincial level. For example, the use of a tax as a means of discouraging excess packaging would have to be imposed at the retail level to capture all domestic and imported products, rather on the much smaller number of manufacturers and importers of packaged goods or on packaging manufacturers.

5.3.4 Capacity to generate technological innovation

Price instruments offer an advantage over technology-based command and control policies because firms are free to select an approach to pollution abatement, leaving greater room for innovation.

Laplante (1990) notes that while Canadian standards are written with certain technologies in mind, the actual limits are expressed in terms of effluent levels. This is the case, for example, in standards being adopted under the MISA program for water pollution control. The MISA standards are being set based on the predicted effluent levels associated with the use of the "Best Available Technology" or the "Best Available Technology Economically Achievable", but with few exceptions, are written as performance standards rather than as government-imposed technology requirements. Thus, in theory, these standards do not impose constraints on the use of more innovative or lower cost approaches identified by a firm or municipality.

In practice, however, the specific technology basis of the standard is likely to induce firms to adopt the technology assumed by the regulator in setting the performance standard.[89] First, in contrast to a price-instrument approach, the firm has no incentive to apply a more effective (i.e. greater abatement) but more costly abatement technology, since there are no incentives for reductions beyond the standard. Second, firms may be reluctant to reveal the existence of such a technology to the regulator, since it would then be incorporated into the standards. Third, firms may adopt the technology assumed by the regulator in setting the standard, so that in the event that they subsequently fail to comply with the standard, they can demonstrate that they made a good faith effort to comply.

Since pollution taxes have generally been imposed as a supplement to command and control policies, there has been little evidence of a differential impact of pollution taxes on

[89]This paragraph draws on the conclusions of Laplante (1990).

the adoption of innovative technologies. Rehbinder and Sprenger (1984) noted that U.S. firms subject to command and control policies appeared to merely adopt the technologies used setting performance standards under a Best Available Technology Approach. However, our review of the Countdown Acid Rain program revealed that, in part due to the long lead times in this program, firms such as Inco were able to develop their own strategies for meeting targets for sulphur dioxide emission controls. Thus, at this point, the evidence suggests that innovation might be generated under a command and control program with appropriate flexibility and lead times.

One potential disadvantage of price instruments relative to command and control relates to the greater extent to which the latter promotes the diffusion of technologies across an industry. Under a price instrument approach, a firm would gain a competitive edge over a rival by preventing rivals from gaining knowledge of innovative, low-cost abatement technologies. Command and control regulations are designed after a thorough review by regulators of the available technologies, and these technologies are communicated to the firms subject to the regulations.

5.3.5 Capacity to induce research and development

In addition to promoting the use of innovative approaches, price instruments are also thought to provide greater incentives for R&D investments towards uncovering such approaches. As Dewees (1990a) notes, "to the extent that an effluent charge simply looks like a cost to the firm, it creates an incentive to minimize costs by ... developing new technology".

In contrast to a command and control program, this R&D incentive not only extends to developing methods of achieving a given abatement target more cost-effectively, but also to uncovering the means for further abatement. Thus, while our review of command and control programs showed some evidence of in-house research by Ontario firms, for the most part, this research was aimed at meeting, rather than exceeding, anticipated or stated performance standards. Laplante (1990) maintains that firms may actually feel that such research would be to their detriment, if it resulted in a tougher BATEA standard. He notes that under the MISA program, "a periodic review of effluent limits" is incorporated into the

legislation, with the review period being in part based on "the rate at which new control technologies are being developed and tested."[90]

However, most of the firms interviewed for this study relied heavily on technologies developed by arm's length suppliers, rather than on in-house research. While some observers, including Olewiler (1990), argue otherwise, it is less clear that command and control offers such firms less incentive to develop new products. Olewiler's argument is that pollution taxes create a ready market for control technologies that achieve abatement at a cost that is less than the tax. However, command and control provides greater incentives for the development of effective, but perhaps high cost, control technologies, since the developer can then attempt to persuade regulators to view the result as the new, best available technology. Furthermore, once the performance of such a technology is adopted as the BAT standard, firms may be compelled to purchase it.

As in the case of innovation, while there is some evidence on the shortcomings of command and control, we are unaware of any evidence of strong R&D performance being induced by a price instrument approach to environmental protection, due to the lack of reliance on such instruments in major areas of water or air pollution control that depend on new technologies.

5.3.6 Monitoring, enforcement and administrative costs

Monitoring, enforcement and administrative costs are frequently cited as a key barrier to the use of taxes and charges for environmental purpose. Indeed, officials in both the Air Management and Water Resources branches of the Ministry of the Environment, as well as industry representatives, cited monitoring and enforcement costs as a significant disadvantage for pollution taxes or charges over command and control systems.

The case study evidence, however, suggests that monitoring, enforcement and administration costs have not proven to be insurmountable barriers to the effective use of taxes and charges. Most of the wastewater charges examined, as well as the household sold waste charges, functioned without major administrative costs relative to the revenues raised (see Chapter 3).

[90]Quoted from Ontario Ministry of the Environment (1987).

This is less of an issue in most deposit-refund systems, where "monitoring" is typically inherent in the granting of refunds based on a easily observed performance criteria (e.g. the return of a container). Indeed, relative to command and control programs, it is clear that deposit-refund systems offer considerable advantages in terms of enforcement. For example, anti-littering laws (fines imposed on those who litter) are notorious for their lack of enforcement, since the cost of monitoring individual behaviour represents a barrier to enforcement. Deposit-refund systems are clearly superior, since they impose a (typically) small but effective automatic fine (the loss of the deposit) on environmentally hazardous behaviour.

In the case of product charges, the same filing mechanisms used for sales and excise tax purposes, based on self reporting by vendors, can be used. Environmental product charges could be implemented at no greater cost than that presently incurred under excise tax systems for gasoline or cigarettes, for example. A high tax on the use of an undesirable item would likely be a far less costly method of restraining use than a set of regulations controlling quantities.

Existing environmental taxes have been applied by jurisdictions only a fairly small number of products, and we have found no evidence that this has imposed a major administrative burden on vendors or consumers. However, if taxes of different rates were applied on a *multitude* of products, there would be increasing costs to retailers and consumers in terms of compliance with sales tax legislation. The general direction in tax policy internationally has been towards more uniform rates of tax that simplify compliance by vendors. The use of product taxes, while administrative less-complex than quotas or other instruments of *environmental* policy, is thus less-desirable than other instruments of *revenue* policy in terms of administrative and compliance costs if used extensively on a wide range of products.

Overall, used with restraint, both deposit-refund and product charge instruments offer major advantages in terms of monitoring and enforcement costs where the policies are designed to alter the behaviour of a very large number of individuals or firms. The remainder of this section therefore focusses on taxes or charges on emissions, where the issue of monitoring and enforcement costs is more contentious.

Initially, in areas where command and control systems are already operative, a shift to a price-instrument or the addition of a price instrument would impose some regulatory development costs. Both industry and government environment officials interviewed by

Ernst & Young suggested that some Ontario programs, such as MISA in certain sectors, or the acid gas controls on major sources, might be too far along for a shift to a wholly different policy approach (e.g. a complete reliance on pollution taxes). The Ministry and the industry have a significant investment in the existing standards, which in some cases represent the results of several years of measurement, technology review and negotiations among business and government representatives. This would not apply in the case of moves to encourage firms to go beyond these standards through the addition of charges or taxes, or in the numerous areas of environmental policy where formal controls remain underdeveloped.

Once in place, the lowest-cost monitoring is achieved using command and control programs that are technology or design based (i.e. the firm is compelled by regulation to install certain equipment, and its installation is sufficient to be in compliance). This type of policy was used, for example, in early regulation of SO_2 emissions in Ontario. If Inco was required to construct a tall stack to disperse its emissions and avoid high ground level concentrations, then monitoring was reduced to verifying that the stack and related equipment had been installed

However, as documented by Laplante (1990), Canadian environmental regulations, including those in Ontario, are increasingly performance as opposed to design based, with control orders setting limits on total emissions. Both the Countdown Acid Rain program and the MISA program are examples of this approach. Performance based command and control programs will not offer the same degree of monitoring savings relative to pollution taxes (or other economic instruments).

For performance based standards, government expenditures on monitoring and enforcement costs under command and control programs have generally been kept modest by a reliance on industry self-enforcement. Laplante (1990) cites Ontario's MISA program as an example, where a Ministry policy document stated that "the Ministry will learn of effluent limit violations by the following means: dischargers will be required to notify the Ministry of violations."[91] This self monitoring imposes significant costs on firms and municipalities, while exempting the province from much of the burden of monitoring and enforcement. In most such cases, the Ministry conducts its own occasional monitoring

[91]Quoted from Ontario Ministry of the Environment (1987)

efforts to verify the accuracy of industry reporting. Furthermore, both monitoring and enforcement in the past has been eased by the fact that many of the Ministry's programs controlled a relatively small number of major point sources on a fairly small range of emissions. As the Ministry moves to dealing with such problems as NO_x and VOC emissions, or the numerous sources being covered under MISA, monitoring costs for both government and industry are certain to increase, even if self-monitoring remains the primary mechanism.

We have not conducted a sufficient review to assess whether or not such self-monitoring is effective.[92] The key point for this analysis is that the same self-monitoring systems have been used for pollution taxes elsewhere, and could be applied in Ontario. Self monitoring has been used, for example, in the European water charge examples reviewed in Chapter 3. Occasional measurements can be used to test these data, much as they are under command and control policies, and substantial fines can be provided for filing erroneous data to provide a sufficient deterrence for under-reporting emissions.

Where taxes or charges are to be the sole instrument for promoting abatement (rather than as a supplement to command and control), the effective rates of tax per unit of effluent are likely to be much higher than those previously used in other jurisdictions. Where the tax rate is high, there may be legitimate concerns that the self-monitoring systems presently used are not sufficiently accurate for the assessment of a tax liability. This might be the case, for example, where current testing is required on only an intermittent basis to verify that a firm is achieving the standard, with no need to accurately assess the extent to which the standard is being exceeded. The German effluent charge system described in Chapter 3 offers one solution to this problem, by using a step function for charges which rewards only significant reductions below the standard. This sacrifices the incentive to make more modest improvements in exchange for greatly simplifying the measurement requirements.

In any event, as Dewees (1990a) notes, "*any* program that is designed to cause substantial abatement at high costs will necessarily require considerable expenditures for

[92]Laplante (1990) questions the use of such systems where the pollutant dissipates rapidly (e.g. many atmospheric emissions), or where emissions from individual sources cannot be traced due to multiple sources in the same ecosystem. His view is that "one should not expect the offender to be forthcoming" in such cases, where the chances of being caught by government monitoring are low.

monitoring and in some cases enforcing the underlying policies", regardless of the instrument used.

Effluent taxes offer advantages in terms of the automatic nature of enforcement. Once imposed, the firm faces clear penalties for failing to abate, and clear financial gains for doing so. Furthermore, in the case of taxes, governments will themselves have a revenue incentive for ensuring adequate enforcement.

This is in sharp contrast to the experience under command and control policies, which in most jurisdictions have seen quite varied enforcement. Environmental groups interviewed for this study, as well as a number of policy analysts, have judged the ability of industry to negotiate delays or simply fail to comply with command and control orders to be a serious failing of the existing system.[93] Of course, this implies that it may be more difficult to legislate effective pollution tax policies, since once enacted there will be far less room for negotiations and political flexibility.

5.3.7 Public, private sector and interest group perception

The ability of the Ministry of the Environment to employ price instruments in environmental protection will inevitably be affected by the views of various groups affected by the policy. Industries subject to MOE regulations generally will be very opposed to tax instruments, but should be less strongly resistant to charges or deposit-refund approaches. The Ministry's own staff, as well as environmental groups, will find price instruments appealing in some applications, but less so in areas where they would substitute for existing command and control programs. The public has indicated its willingness in some public opinion polls to pay for the costs of a cleaner environment, and may be less resistant to "green taxes" than other forms of revenue-raising by governments.

Industry Views

Industry groups have generally been opposed to the use of emission or effluent taxes as a mechanism for environmental policy. This opposition was evident during the formulation of most of the programs reviewed in Chapter 3, as well as in virtually all of our

[93] Bonsor (1990) concluded that the set of regulations on pulp and paper water effluents "has not been enforced" over the past 20 years." Dewees (1990a) argues that "debate seems to have heavily overshadowed abatement" in the North American auto industry in the 1960s and 70s, the Canadian pulp and paper industry in the 70s, and, until recently in controlling sulphur dioxide emissions in Canada and the U.S.

discussions with industry environmental officials in Ontario. Hahn (1989) cites strong industry resistance to pollution taxes in Italy. While corporate, head office views can sometimes sound supportive of these tax-based instruments[94], the reality in the cases we have reviewed suggests that governments will tend to face stiff industry opposition to effective tax schemes (i.e. those at rates high enough to induce abatement and affect product demand).

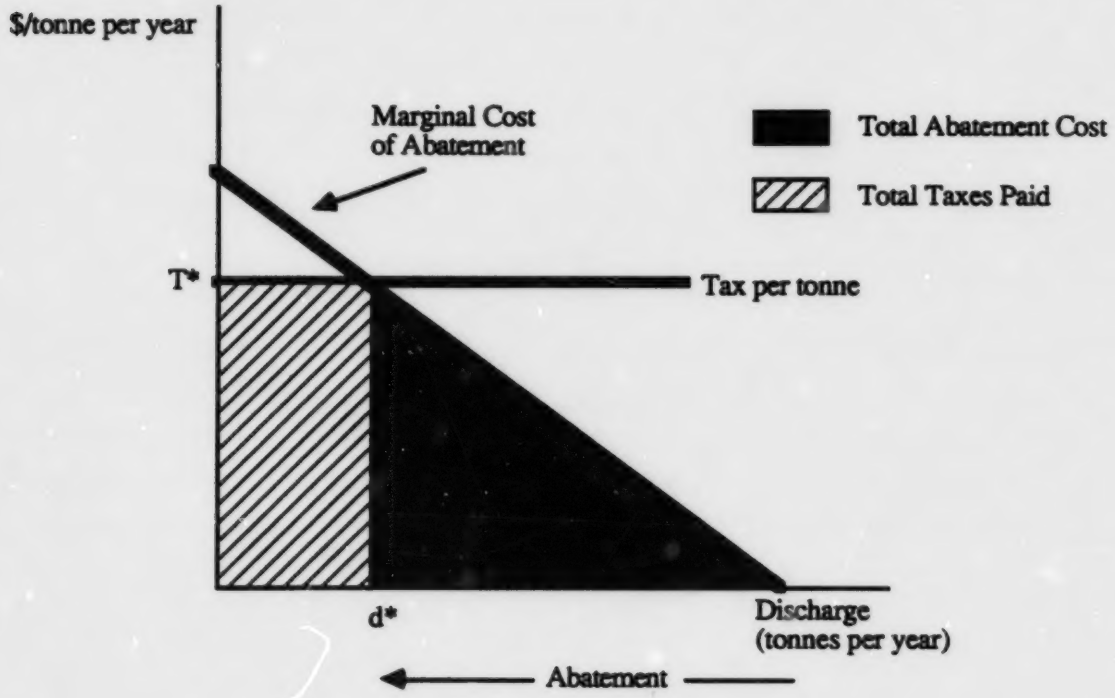
There are several reasons for this opposition to the use of pollution taxes:

- once imposed, they do not allow for the type of negotiated delays in abatement efforts that have proven possible under command and control;
- lobbyist have grown comfortable and knowledgeable in working within the current system, and therefore resist fundamental changes that would, according to Hahn and Stavins (1990), lead to a "dissipation of their human capital". In our view this may be more of a factor in the U.S. political system than in our own;
- municipalities subject to such taxes on their facilities would create local political resistance, and might seek to have the province recoup the financial cost to them;
- many command and control programs favour existing firms (and their workers) over new entrants, an advantage not granted to existing firms under a pollution tax policy;
- pollution taxes impose a higher cost on an industry than an environmentally-equivalent command and control or un-auctioned marketable permits approach.

The last of these points, first demonstrated by Buchanan and Tullock (1975), is most easily understood through reference to Figure 5.2, adapted from Dewees (1990a).

[94]For example, according to Hahn and Stavins (1990), General Motors has endorsed the use of carbon taxes to combat the greenhouse effect.

Figure 5.2
Costs to the Firm of Pollution Tax vs. Discharge Limit



The downward sloping line in the chart shows the additional costs incurred by the firm for an added unit of abatement (where abatement is measured as reductions from the maximum level of discharges possible). These costs tend to rise at lower levels of total discharges (i.e. higher levels of abatement), since removing the last 10% of emissions typically involves greater costs than the first 10%.

The dark shaded area shows the total costs incurred by the firm as a result of a command and control policy requiring discharges to be reduced to the level d*. A tax imposed at the rate of T* dollars per tonne would also induce the firm to reduce emissions to d*. Under such a policy, the firm would not only pay the same total cost of abatement, but would also pay the diagonally striped area in total taxes on the remaining emissions. As one paper company representative put it:

> "BOD treatment for a major mill can cost $20 million. You would have to have a very high tax on effluents for companies to be willing to spend this amount. If a mill has already spent money curbing the BOD effluents through a major capital expenditure, then it is unfair to apply an additional effluent tax"

There are a number of assumptions underlying this argument that pollution taxes will impose greater costs on industry. First, the "standards" assumed above are fixed levels of emissions. Where technology requirements are imposed, these could be more costly to the firm than the sum of the least cost abatement technology plus the pollution taxes paid. Second, some firms may have a competitive advantage in abatement costs, enabling them to earn extra-normal profits as a result of price increases induced by the tax and abatement cost burden of others. Finally, any taxes raised by governments are, to some extent, substitutes for other sources of tax revenue, which might therefore be lower in a system that made more extensive use of pollution taxes. Thus, some industries or firms would benefit by potential reductions in corporate tax liabilities.

In this regard, pollution charges, where the funds are used for designated environmental purposes, are less likely to be opposed by industries if the charge revenues flow back to the industry. For example, the charge systems in France were used to raise funds for specified water treatment projects, and Hahn (1989) cites evidence that charges have had high political acceptability in France. Sweden's NOx emissions fee on large furnaces, to be instituted in 1992, will be revenue-neutral, with all funds raised returned to the facilities as a group based on their energy production.[95] Such a system creates winners and losers within the industry, with firms making greater use of the funds gaining at the expense of others in the same industry. Hahn (1989) argues that distributional concerns play a key role in motivating the use of charges rather than pollution taxes.

It should also be noted that industry has in a few cases voiced its support for pollution taxes as a substitute for more interventionist regulatory policies and existing taxes. For example, General Motors (in the U.S.) has stated that it favours a carbon tax levied on all fuels over the current mix of gasoline taxes and Corporate Average Fuel Economy (CAFE) regulations for motor vehicles.[96]

Deposit-refund systems impose only minor net costs on an industry, and can actually enhance profits depending on the costs of recycling or reusing returned items. Anderson et al (1989) show that, ignoring the costs of administering the system and the value of returned items, deposits leave the total sales and profits of an industry unchanged.

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[95]As described in U.S. EPA (1991).

[96]See quote from GM Vice-President George Eads in Tucker (1991).

Consumers returning the item gain while those who fail to return lose. Where costs of administering the system (handling returns, re-using containers, etc.) are high, industries oppose deposit-refund systems that give advantages to substitute products or imports.

Environmental Group Views

Environmental groups have frequently been characterized as being solidly opposed to the use of price instruments for environmental protection, largely on the grounds that they give the appearance of firms paying for a "license to pollute".[97] The reality, however, is far more complex than would be indicated by this simple characterization. Support for the use of economic instruments in general has been growing among environmental groups in North America.[98] Based on discussions with three leading environmental groups[99], we have concluded that such groups in Ontario are likely to support a number of potential applications of pricing instruments, while remaining solidly opposed to others.

While recognizing that some progress has been made, environmental groups have been highly critical of past efforts using command and control policies. For the most part, the failures are attributed to a lack of political will to establish and enforce stringent control requirements, rather than due to an inherent shortcoming in command and control methods. However, environmental groups have also been critical of a number of aspects of the command and control structure. Among these areas of criticism are: the secretive negotiation process between companies and regulators used to establish control orders, the reliance on polluter self-monitoring, the low levels of fines, and the lack of resources for enforcement.

Opposition to the use of pricing instruments would be strongest in the case of persistent toxins (e.g. PCBs, Dioxins, etc.) where the Ministry of the Environment has in most cases already set a goal of "virtual elimination" from the ecosystem. Greenpeace, for

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[97]This generalization is repeated, often without attribution, in most of the literature on economic approaches to environmental protection. Anderson et al (1989) for example, say that "environmentalists histroically object to anything that smacks of a right to pollute."

[98]See Hahn and Stavins (1990) for a review of increasing support in the U.S.

[99]Interviews were conducted with senior representatives from Pollution Probe, Greenpeace and the Canadian Environmental Law Association.

example, would be opposed to any approach that failed to promote "zero discharge" of such toxins. There might be some acceptance of a brief phase-out program which could include the use of taxes as an incentive for a more rapid phase out, but for the most part, there is strong opposition to allowing a firm to trade-off abatement costs and taxes in these areas.

There is, however, fairly broad support for the use of taxes in areas where the objectives are for the reduction rather than the elimination of emissions, particularly where mass behaviour must be influenced. In some cases, the tax would be supplemented by a command and control ceiling on emissions by any one source. Among the types of applications generally viewed favourably by environmental groups are:

- carbon taxes, placed on fuels and other source of CO_2 emissions, with a view to combatting the greenhouse effect[100];
- eliminating subsidies and adding taxes as necessary to promote full cost pricing of resources and conservation in a wide range of areas, including electric power generation, off-shore oil drilling, agriculture, waste disposal (tipping fees), and logging;
- expanded use of deposit-refund systems to promote re-use or recycling.

In the case of solid wastes, some environmental groups view taxes and deposit-refund systems as an interesting but insufficient policy approach. Greenpeace, for example, favours compulsory (i.e. command and control) programs to require source separation of wastes by companies, and outright bans on disposable packaging and other items flowing into the solid waste stream. There is a suspicion that taxes would not be set high enough to induce firms to source-separate their waste products or to eliminate excess packaging. For the remaining solid items, deposits are seen as a useful methods of ensuring returns for re-use. The Greenpeace representative was opposed to the heavy use of taxes on households due to concerns over the resulting income distribution impacts.

Our interview respondents were also unanimous in expressing the view that the revenues raised through environmental taxes should be used for targetted environmental purposes. There was some fear that taxes flowing to general revenues would lead to conflicts between government revenue objectives and environmental policies. One

[100]Such a tax is gaining support among environmental groups worldwide. The U.S.-based Worldwatch Institute is among the proponents of greenhouse gas taxes, according to Tucker (1991).

suggestion was that taxes on environmentally damaging products could raise funds for subsidies for environmentally-friendly alternatives.

Ministry of the Environment Staff Views

The professionals within the Ministry of the Environment groups responsible for air, water and solid waste issues will have to play an important role in developing and implementing new approaches to environmental management. We therefore explored the views of a sample of four Ministry officials to ascertain the existing degree of support for price (and other economic) instruments. While not necessarily representative of all of the viewpoints in these branches, the interview subjects were individuals with significant responsibilities for environmental protection in their fields.

We found that there was considerable support for price mechanisms in solid waste management, some support in water pollution control, and opposition to price instruments in air quality management.

In the case of air pollution control, our interview respondent was generally opposed to the use of economic instruments, including pollution taxes. First, for some "level one" emissions, the Ministry's objective is zero pollution or the closest technologically achievable. For these emissions, taxes would be a license to pollute above the Ministry's zero or near zero objective. Second, for other emissions, the Ministry seeks to control local ground level concentrations, and there is a view that quantity-based instruments are needed to ensure this.

Finally, the respondent argued that accurate measurements for some emissions would be difficult to obtain (e.g. leaks of VOCs from chemical plants). The Ministry would have to perform detailed audits or take actual measurements, either of which would require substantial manpower. An alternative would be for the Ministry to set up a methodology for companies to use in measuring leaks, but this would still require an audit to make sure that the measurements were being taken properly, and and it would be difficult to punish firms if they made a 'mistake' in the measurement procedure.

Our two respondents from the Water Resources Branch differed in their views on the potential use of emissions taxes. One felt that the Ministry's timetable under MISA was too short to permit any significant changes, and that in a sense the Ministry was too far down the road in its existing process to make any major changes. The same respondent

also doubted that the public would accept taxes levied on discharges where these were self-monitored, and that higher cost measurement methods by the firms or by MOE would not be feasible. A second respondent felt that effluent taxes would be a very useful supplement to command and control policies, to encourage reductions beyond those mandated by control orders. While he recognized the potential for industry opposition, he argued that European firms were already faced with similar types of fees.

The waste management branch, which has been less involved in direct command and control regulation, is a strong supporter of the use of price instruments. Indeed, our respondent noted that "the policy of the province is to adopt user-pay approaches to solid waste management." The Ministry is investigating means by which municipalities would be able to measure and recover the 'true costs' of municipal solid waste management activities, and provide a greater incentive for 3Rs initiatives.

"Pay-per-bag" systems for households have at this point only been discussed, and their implementation would be the responsibility of municipal governments. Solid waste taxes at the provincial level might be viewed as an intrusion into municipal jurisdiction, but the province might use such taxes to pay for programs that they are funding for municipalities in this area, such as the "blue box" program. Alternatively, the province could use its grants for municipalities (expected to reach $100 million by 1992) to encourage municipalities to adopt user-pay approaches.

Public Opinion

Public opinion polls have shown a strong concern for environmental quality in Canada and Ontario. While we know of no specific poll on environmental taxes, the polls have shown that Canadians are willing to pay more for environmentally friendly products. Seattle found high public acceptability for pay-per-bag charges for solid waste.

In the absence of hard data, we can only speculate on the types of factors that would make pollution taxes more acceptable to the general public. The following circumstances, in our view, are likely to help to generate public support for new environmental taxes:

- the tax is announced as a direct replacement for an existing tax. Seattle's pay-per-bag charge replaced a fixed charge for household garbage pick-up, for example;

- revenues are to be used for a designated environmental purpose. This would link the tax directly to a popular environmental cause. Since formal earmarking of revenues may be undesirable from a rational budgeting perspective, an alternative means of providing the perception of linkage could be used, such as simultaneously announcing a new environmental spending program with first-year costs equal to the first-year revenues raised by the tax;

- individuals believe that they have reasonable alternatives available that would enable them to avoid the tax (e.g. the substitution of recycling or reuse for disposal in the case of solid waste charges).

5.3.8 Suitability and effectiveness as public financing mechanisms

Pollution taxes and charges would serve as a mechanism for raising funds, for general Ontario government purposes in the former and for targetted environmental purposes in the latter. Thus, not only should such systems be judged in terms of environmental impacts, but they must also be compared with other alternatives for raising government revenues. In the following, we highlight the strong performance of pollution taxes on efficiency grounds, the positive and negative impacts on equity, and the merits and demerits of targetted taxes vs. additions to general revenues.

Efficiency Implications

Section 3.4.2 reviewed some of the important economic efficiency advantages arising from the use of effluent taxes in Europe. For the most part, such efficiency gains can be achieved in other applications of "green taxes". The efficiency (social welfare) gains from pollution taxes include:

1. internalizing the cost of pollution within a firm. The "polluter pay" principle is consistent with economic efficiency, since the firm's decision on whether and how much to produce should compare revenues to all private costs (labour, capital, etc.) as well as the social costs of pollution. As discussed in section 5.3.2, reductions in output or investment in an industry that result from such a tax are (in the case of competitive industries) likely to be economically beneficial, since output in a polluting industry will generally exceed the social optimum in the absence of a tax that internalizes (i.e. makes the firm pay) pollution damage costs.

2. pollution taxes can substitute for other taxes that deter economically advantageous activities (labour supply, savings and investment);

3. pollution taxes let the firm select the cost-minimizing abatement strategy.

Equity Considerations

Pollution taxes generate mixed performance in terms of equity criteria. When imposed on the public, they tend to be regressive. Taxes imposed at the corporate level can be borne by shareholders, workers or consumers, and the equity implications are not clear. However, pollution taxes can be used to fairly allocate the costs of operating public water treatment and solid waste facilities, to tax away profits generated by environmental policies that limit production, and can eliminate inequities in the treatment of firms that are inherent in many command and control programs.

Since they are not well-linked to "ability to pay" or progressive in terms of their impact on various income groups, a shift from income taxes to "green taxes" on consumer products is likely to be regressive. The regressivity of pollution taxes could be offset through the use of some of the revenue to pay for refundable credits to low income households, as was done in the case of the GST. Similarly, pollution taxes imposed on industry are not well linked to profits – a measure of firms' ability to pay.

Deposit-refund systems benefit consumers who return items for deposit at the expense of those who do not. It is not clear whether or not returns are more or less likely from low income groups. We suspect that environmental consciousness increases with educational attainment (and thus with income), but at the same time a given deposit will be more valued by a low income consumer. Deposit-refund systems imposed only on domestic products (e.g. for reasons of practicality in reusing imported containers) can create inequities between domestic and foreign producers.

The equity impacts of pollution taxes levied at the corporate level are less easily understood. In practice, a tax on discharges can be borne in whole or in part by labour, capital (i.e. shareholders), other input suppliers, or consumers, with the relative shares depending on various elasticities of supply and demand. Since there is still disagreement among economists on the incidence of more well-used taxes, it is not surprising that the existing literature on pollution taxes is devoid of any conclusive evidence on the overall incidence of pollution taxes.

In the case of well-traded products where Ontario firms are likely to be price takers, as might be the case in many of our major resource industries, taxes at the corporate level are likely to be borne by producers and their workers. In other cases, some of the tax will be passed on to Ontario consumers.

Pollution taxes are likely to outperform command and control policies in terms of the equality of treatment among firms. Command and control programs frequently favour existing firms over new entrants, a factor not present in tax systems. The preference in command and control programs can create a barrier to entry by new firms, and entrench oligopoly pricing that has economic efficiency costs.

Environmental taxes can also be viewed as a fair method of raising funds to pay for publicly-provided environmental services. Many of the fees in place in other jurisdictions, and the increases in tipping fees imposed in Ontario, are designed to make users pay for their fair share of the costs associated with water treatment or solid waste management. Such "user charges" eliminate subsidies for pollution generators from general tax revenues. The funds raised can also be used to compensate victims of environmental damage.

Environmental taxes can also be used to tax away windfall gains to firms that would otherwise see profit increases due to environmental measures. The U.S. Congress adopted a tax on CFC producers to eliminate the windfall gains to such firms associated with the implementation of quotas (which would drive up the prices and profits of grandfathered producers).

Targetting of Funds

Targetting the revenues raised from pollution charges for environmental purposes has both advantages and disadvantages from a fiscal policy perspective. As we noted above, targetting the revenues is likely to generate increased support for the policy from industry, environmentalists and the general public. However, as noted by a Treasury official, targetting is undesirable from a prudent budget management perspective. Making a direct link between environmental taxes and environmental expenditures does not necessarily mean that sufficieint funds will be available to address environmental problems. Revenues from these taxes are likley to vary from year to year, and targetting could lead to inadequate funding in a year in which revenues are down. In principle, expenditure decisions should be made according to the priorities of the government, and not based on how the money was raised.

Thus, a preferred approach, as noted above, would be to informally link a new environmental tax to a new environmental spending program, while leaving future-year program expenditures and pollution tax revenues flexible.

5.3.8 Implications for international trade competitiveness

As discussed above, unless imposed as a direct substitute for existing business taxes, pollution taxes impose a higher cost on an industry than charges (where charge revenues flow back to the industry), deposit-refund systems, or performance-based command and control policies. In the European cases examined in this study, pollution taxes have been set at rates that were too low to pose a signficant competitiveness problem, but this would not be the case if taxes were used as the key means of inducing high cost abatement measures.

The additional tax burden can therefore be an impediment to the competitiveness of Ontario industries subject to taxes not borne by firms in other jurisdictions. The extent to which this would be a problem would depend upon the tradeability of the product (transport costs and other barriers to trade), and the resulting ability of firms to pass on these costs to consumers.

Pollution taxes imposed on consumer purchases also have implications for competitiveness in terms of their impact on cross-border purchasing. Gasoline taxes, for example, are already contributing to a significant outflow of consumer dollars as a result of the high price differential between Canada and the U.S.

A number of options are available to cushion the impact of industrial pollution taxes on international competitiveness. First, when imposed on industry, the taxes could be used as a direct substitute for existing corporate income or capital taxes on the same industry. Pollution taxes would raise funds for waste management and other activities that are presently funded from general tax revenues which are also borne in part by industry. Furthermore, as pollution taxes improve environmental management by providing incentives for pollution abatement, they will reduce the overall public sector costs for environmental protection (and thus the need to cover these costs from overall tax revenues).

Second, as in some European jurisdictions, financially weak firms could be granted temporary exemptions. Third, the tax could be set at zero for firms undertaking significant abatement efforts (as in Germany). Finally, taxes on consumer products could also be imposed at the border on imported goods, with the cooperation of federal customs officials.

Olewiler (1990) also points out that in some cases, depending on market structures, a unilaterally imposed pollution tax can increase incomes in the country imposing the tax. Furthermore, although pollution taxes may harm the competitiveness of the firms paying them, the resulting environmental improvements can be an attraction for a jurisdiction in terms of the quality of life offered to employees.

5.4 Conclusions

Price mechanisms have both strengths and weaknesses as instruments of environmental policy. The most serious weaknesses lie in the fact that policy makers will find it difficult to set the tax rate in advance in order to achieve the desired level of abatement, and in the difficulties that governments face in attempting to impose sufficiently high taxes to induce abatement. The chief advantages of price instruments lie in their ability to generate responses by large numbers of firms and households without a complex set of regulations, and in the economic efficiency gains achieved in using pollution taxes to raise government revenues.

Ontario has not made extensive use of price instruments, despite clear successes achieved in bottle recycling and re-use through deposit-refund systems. As we review in Chapter 7, there are a number of areas where such instruments could be applied to good effect, primarily involving extensions to environmental policy rather than substitutions for existing command and control programs.

6. GENERAL FINDINGS ON THE USE AND PERFORMANCE OF QUANTITY-BASED ECONOMIC INSTRUMENTS IN ENVIRONMENTAL PROTECTION

6.1 Applications of Quantity Instruments to Environmental Protection

There are two-types of quantity-based economic instruments for environmental protection. **Marketable permits** (also termed emissions trading or effluent trading) grant firms a right to undertake a certain level of environmentally damaging activity. This could include the right to produce a harmful product, or the right to a given level of waste discharges into a particular medium. The permits can then be bought and sold among those granted the rights.

To date, applications of this approach have largely been in the United States. In Chapter 3 we reviewed emissions trading under the Clean Air Act, lead trading for gasoline refiners and importers, and effluent trading on the Fox River in Wisconsin. Other U.S. applications include effluent trading in the Dillon Reservoir area, and the newly enacted trading program under the Clean Air Act to control acid gas emissions. The U.S. has also proposed international trading of carbon emissions as a means of combatting the greenhouse effect. Germany has an "offsets" program which enables a new facility to purchase the air emissions permit of an existing plant that is being replaced, and enables credits to be generated by plants undertaking renovations. Ontario, and some Scandinavian jurisdictions, allow some intra-firm trading. Dewees (1990b) notes that the Countdown Acid Rain program already incorporates the "bubble" concept (intra-plant and intra-firm flexibility).

Auctioned permits differ from the typical emissions trading approach in that permits are initially sold to the highest bidder. They may or may not be subsequently eligible for further trading among firms. Although widely discussed in the theoretical literature, and used for resource management (e.g. oil leases in the U.S.), we are not aware of any examples of this approach being applied to date in North America. Singapore used an auction system to allocate quotas for emissions of CFCs. The price per ton of was initially bid up to $4,000, but it later fell as low as $500 per ton as companies found more cost-effective substitutes or emission control methods.[101]

[101] Tucker (1991).

Canadian policies to comply with the Montreal Protocol to protect the ozone layer have some elements of this approach. For *producers and importers* of CFCs and halons, a fairly traditional command and control approach was used. These suppliers were given fixed quotas, based on their activity in 1986, although they were allowed to substitute among the various types of CFCs or halons as long as the total potential ozone impact was kept constant. *Users* of the limited supply of CFCs and other ozone depleting substances must bid in the open market for these,[102] and thus the market is used to "auction" the constrained total supply of CFCs and halons and to determine which ones will be phased out first. This is in contrast with the U.S. system, which set quotas for both producers and users of such substances, according to Anderson et al (1989).

In the remainder of this chapter, we provide general conclusions on the performance of quantity-based economic instruments for environmental protection relative to command and control. Marketable emissions permits and other quantity-based economic instruments for environmental protection share some of the features of the pricing approaches reviewed in Chapter 5. Thus, on several criteria, the comparison between quantity-based approaches and command and control policies involves similar issues as those reviewed in the previous chapter. *Rather than repeat these arguments, where appropriate, we refer the reader back to various sections in Chapter 5. Our focus here is on those areas where quantity based approaches offer differing strengths and weaknesses that those described for price instruments.*

6.2 Effectiveness of Quantity-based Economic Instruments

6.2.1 Capacity to protect and improve environmental quality

Marketable permits are typically designed to match, rather than exceed, the environmental performance of an alternative command and control policy. The cost reductions achieved through this approach may in some cases enable policy-makers to press for more stringent overall requirements, and thereby enhance environmental quality. On the other hand, unless carefully designed, permits may reduce the level of abatement relative to command and control programs, by enabling firms to sell credits for abatement activities they would have undertaken in the absence of the trading program.

[102] See Smith (1990) for a favourable review of this program.

The case studies in Chapter 3, as well as evidence from simulations of newer U.S. trading programs in both air and water pollution control, suggests that a well-designed trading program can achieve effective abatement. The lead trading program, for example, achieved a rapid reduction in gasoline lead content, and it is likely that the pace of abatement was enhanced due to the flexibility facilitated by trading. The Bush Administration lent its support for significant abatement under the revised Clean Air Act in part due to the reductions in overall abatement costs achievable through an emissions trading system.[103] The previous experience with emissions trading under the Clean Air Act, as reviewed in Chapter 3, exposed several problems in terms of its environmental impact, and these were largely addressed in the most recent revisions to the program.

Marketable permits have an important advantage over price instruments in terms of their ability to protect the environment. Permits provide the regulator with a degree of certainty over abatement responses that is not available using taxes or charges. In the latter, the response will depend on various elasticities that the regulator may not be able to estimate in advance.

Permits have an advantage over both price and command and control instruments in that they directly incorporate the impact of economic growth and new plants on discharges. A permits approach compels the regulator to set a fixed level (or growth path, in the case of permits re-issued over time) for *total* discharges. Higher than expected economic growth, with unanticipated growth in the number of pollution sources, then requires the new sources to purchase permits from additional reductions achieved by existing sources, or compete with existing firms for auctioned permits.

Command and control policies, where the standard restrains total emissions (rather than merely mandating a particular technology), can cap emissions growth at existing facilities as their activity expands. Command and control policies also general entail a requirement for a permit for the establishment of new sources, which compels them to meet certain technological or discharge standards. However, if economic growth leads to an unanticipated expansion in the number of new plants, command and control can fail to achieve a given total emissions or ambient standard target, despite the fact that each source

[103]See Hahn and Stavins (1990)

is meeting the standard. Similarly, a given pollution tax or charge will result in greater emissions over time as the number of sources grows.

The case study evidence revealed a number of other important factors that affect the ability of marketable permits to achieve environmental objectives:

- *Knowledge of baselines*. Where permits are initially allocated as a share of some historical level of discharges, it is important that such levels are accurately assessed. Otherwise, firms granted excess permits may generate emissions credits for sale without actually taking steps to reduce their emissions.

- *Setting of overall limits*. Oates et al (1989) showed that if a given standard (per plant) is established under command and control, some firms will tend to more than meet the standard, with the overcontrol arising due to the discrete nature of the available technologies. Thus, a marketable permit approach that assigned each firm the right to discharge this same standard amount would achieve a lesser degree of overall abatement, since all of the firms that would have overcontrolled would be selling credits to other firms. This suggests, for the programs to result in the same total discharges into the environment, the target for overall discharges under a marketable permits approach should be set lower than the sum of the discharge limits of individual firms under command and control. An alternate approach, pursued in some U.S. applications, is to require the seller of a discharge permit to generate a greater amount of abatement than sold to the purchaser.

As in the case of price instruments, differences in the environmental damage caused by emissions from different sources can pose difficulties in the use of quantity-based economic instruments. Auctioned or traded permits systems set an overall level for discharges, but allow the distribution of these discharges to be determined by market forces linked to differing marginal abatement costs. However, changes in the allocation of emissions across sources can pose environmental problems where there are:

- local pollution problems - i.e. where the media into which discharges occur is not perfectly mixed;

- transboundary pollution problems - relations with other jurisdictions could be strained if trades were permitted that weakened emission controls at facilities located closest to the border (e.g. trades in acid gas emissions between Hydro facilities in Southern Ontario and Inco)

- seasonal or episodic pollution problems – emission reductions in one period of the year or on a given day may not offer an equivalent environmental benefit due to differing capacities of river bodies or air masses to absorb or disperse pollutants;

- differences in the chemical composition of emissions (e.g. in the chemical content of VOCs emitted by different firms).

Regulators can design permit approaches that restrict trades to ones that are environmentally equivalent. Regional or local trading areas could be established with trades restricted to firms in a given region or body of water. However, these can in some cases reduce the number of potential traders in the market to the point where little or no trading takes place. The case study evidence suggested that in such circumstances, the permits approach essentially becomes a command and control policy.

In the case of non-equivalent locations within a region, sources in a more sensitive location could be required to hold more permits per unit of discharge than other sources. For example, if a 2:1 trading ratio were required, the firm in the sensitive location would be required to buy a 100 ton reduction from another source in order to increase its emissions by 50 tons. This would ensure that the environmental effects of the additional abatement of a permit seller are at least equivalent to the impact of the additional emissions generated by a permit purchaser. In the case of air pollution, for example, the Ministry already undertakes sophisticated modelling that would enable it to establish such ratios for some pollutants.

For shorter-term episodes (a problem in air quality control), a marketable permits system could include provisions for short-term overrides of permits by the Ministry of the Environment, similar to the present policy of tightened emission limits under adverse weather conditions.

Similar to the case of price instruments, auctioned or marketable permits would not be an appropriate long-term policy where the discharges involved are highly toxic, since the objective might then be to achieve the maximum abatement possible at each and every source. However, permits could still be used if, for economic reasons, one was prepared to allow a phase-out period for such discharges.

6.2.2 Efficiency in Resource Allocation by Polluters

The Theoretical Ideal

Under ideal circumstances, quantity-based economic instruments offer key advantages over command and control in terms of efficiently allocating abatement resources across polluters.

Similar to price instruments, either marketable or auctioned permits systems achieve a given level of total abatement at the lowest overall cost. Firms with low abatement costs will tend to generate additional abatement for sale to those with high abatement costs, and with a sufficiently liquid trading market, trading will lead to equalized marginal abatement costs.

As discussed in Chapter 5 and in our case studies in Chapter 3, there is ample evidence that command and control policies fail to minimize the cost of achieving their target level of pollution control. The U.S. emissions trading program is the only case where the savings of tradeable permits has been firmly documented, and the heavy restraints placed on trading in this program resulted in savings of only 1% of total air pollution control costs. Simulation estimates for the trading of CFC permits in the U.S. and SO_2 and NO_x under the new Clean Air program have shown savings of 20-50% of total abatement costs relative to command and control. The heavy trading under the lead trading program in the U.S. likely implies that significant savings were achieved under this policy.

Quantity instruments do not necessarily lead to the "economically efficient" level of total abatement, as was the case with an idealized price instrument (one where a pollution tax was set at the marginal damage of discharges).

Efficiency Considerations in a Non-Ideal World

The efficiency gains discussed above are fully-achievable in cases where discharges from individual sources are environmentally equivalent, and where there are sufficient numbers of potential traders to create a liquid market (i.e. one with active trading) in discharge permits or a competitive auction of such permits.

Efficiency gains are only realized under marketable permits approaches where an active market in permits develops. As shown in the case studies, this has not always been present in previous applications of this approach to environmental policies. The case studies suggest that the following conditions contribute to the emergence of an effective market in discharge permits[104]:

[104]Similar conclusions are reached in Tripp and Dudek (1989), and Dudek and Palmisano (1988).

- *A moderate to large number of traders (more than 2 or 3).* Where the number of potential traders becomes very large (in the hundreds) independent brokers may emerge to match buyers and sellers effectively. If not, a government-run brokerage system (on a fee for service basis) could be used. Permits would be impractical for extremely large numbers of polluters (e.g. households) in the absence of brokers.

- *Guaranteed property rights.* The permits must carry a clear, guaranteed right to discharge a given quantity for a set period, with no chance of revocation.

- *Minimal restrictions / approvals.* Extensive review requirements for trade approvals have tended to limit the degree of trading activity, by forcing firms to undergo all of the costs of reaching a deal without certainty over its ultimate approval by government.

- *Built-in to environmental program.* Linked to the previous condition, trading has worked better when it has been built-in to the original design of an environmental policy, rather than merely grafted on to an existing command and control policy. In the latter circumstances, the various restrictions imposed under the command and control program have tended to interfere with the development of markets in permits.

- *Strong enforcement.* Purchasers must be convinced that their expenditures on permits are necessary. That is, it must be clear to them that firms that have not purchased or retained sufficient numbers of permits for their discharge levels will be subject to heavy penalties.

A number of difficulties can arise in the use of permits where the number of potential traders is "small". First, the market may fail to establish a single trading price for permits, leaving firms with unexploited trading opportunities. While trading would then fail to minimize costs, it would still result in a reduction in abatement costs relative to a fixed command and control approach. In the extreme, as in the Fox River case, trading can be virtually nonexistent, and the program would revert to a command and control policy.

Second, where these traders are in the same industry, there is a danger that firms would withhold permits from the market in order to prevent the entry of new competitors. This a problem where permits are allocated free to existing firms, and where new sources must purchase permits from existing sources.

Mallory (1990) argues that this could be the case in a permit system for the control of acid rain in Canada. Existing firms, having been granted permits, would have a large edge over new entrants. According to Mallory, they might withhold permits in order to block entry into their industry. However, we would note that international competition would still be present in many industries, making this entry deterring strategy ineffective in

restraining competition. Furthermore, Ontario Hydro would be a major permit holder and Algoma a minor holder, and neither would have an incentive to collude with non-ferrous metals producers to exclude new producers.

A more plausible problem is that firms would hoard permits due to uncertainty over their future growth requirements. To solve this problem, Mallory recommends an auctioned permit system, where permits would be re-issued through open auctions every five years. This would place new entrants on an even footing with existing firms, and ensure that all of the available credits are in fact placed on the market. An alternative, proposed by the Bush Administration for the U.S. acid rain program, is that firms selling permits would cede some fixed percentage to the government, which would then conduct an open auction.

Further efficiency considerations arise where the environmental medium into which discharges occur is not perfectly mixed, for the same reasons as discussed for pricing instruments in Chapter 5. A permits trading system, which allocates abatement effort based on the costs per unit of discharge abated, would then be inefficient in terms of achieving a given ambient standard. For the latter, one would want to take into account the differences not only in abatement costs but also in the contribution to ambient quality made by equivalent reductions in the volume of emissions at different sources. The same issues also arise where the traded discharges are not environmentally equivalent for reasons of differing chemical properties.

As noted above, one can address this issue by requiring trading ratios of other than one-to-one (i.e. one firm must reduce by 2 tons for every 1 ton added by a second, less favourably located firm). However, imposing such weights on trades increases administrative problems and requires a detailed understanding of the linkages between individual source discharges and environmental damage.

In sum, marketable permits offer the potential for significant cost savings in meeting environmental protection targets only in certain types of applications. The savings will be smaller, or nonexistent, in cases where imperfect mixing, local pollution problems, or the need to quickly eliminate a very hazardous contaminant precludes allowing trading among polluters.

6.2.3 System adaptability

Both command and control and marketable permits systems can incorporate pre-determined changes in regulatory policy. In command and control, firms can be advised of standards well in advance of their implementation, as was the case in Ontario's Countdown Acid Rain program, and the standards can incorporate a built-in phase-out of discharges. As long as this is pre-defined, marketable permits can also have a declining value in terms of discharges allowed per period. This can be accomplished by re-issuing permits each quarter, as was in effect done in the lead trading program in the U.S., or by issuing permits whose value (e.g. in tons per year) is reduced each year according to a set schedule.

Long-term marketable permits may be less adaptable than command and control in the event of *unforeseen* circumstances. If firms are purchasing and selling permits, the rights they are purchasing (in terms of future emissions) must be inviolate, and not subject to frequent "expropriation" by regulators. One possibility for avoiding the need for such expropriations of discharge rights is to make all permits subject to a fairly short expiry period - say, five years. The difficulty in such cases is that the market for permits tends to lack liquidity as the five-year expiry draws near.

Permits offer the potential for introducing inter-temporal flexibility in pollution control policy. By permitting banking and subsequent withdrawal of permits, firms can be permitted additional emissions in one period in exchange for greater abatement in other periods. This might be allowed for such emissions as CFCs, for example, where it is the total volume of emissions over a long period that is of issue. This type of adaptability would not be desirable where the objective is to meet an ambient standard for a pollutant that is dispersed over time, since in such circumstances, a surge in withdrawals could lead to exceedances of the ambient standard.

As in the case of pricing instruments, but not in command and control, marketable permits approaches will lead to automatic adjustments in abatement activity at individual firms as abatement costs change over time. However, in contrast to pricing instruments, the *total* level of emissions will not be reduced in the event of a fall in abatement costs, since firms will sell any additional abatement to other firms.

6.2.4 Capacity to generate technological innovation and capacity to induce research and development

Marketable or auctioned permits share the same strengths and weaknesses as pricing instruments in terms of inducing the use and discovery of innovative methods of abatement. Permits generate the same types of financial incentives for such innovations. We therefore refer the reader to the analysis in Chapter 5 for a comparison of economic instruments and command and control on these criteria.

6.2.5 Monitoring, enforcement and administrative costs

While monitoring and enforcement costs are frequently raised as an objection to marketable permits approaches, they have not proven to be an overwhelming problem in U.S. applications to date.

Marketable or auctioned permits require the same types of monitoring and enforcement activities as price-based instruments. Thus, the comparisons made in Chapter 5 between price and command and control approaches would also generally apply to a comparison between tradeable permits and command and control.

A key difference between marketable permits and price instruments arises in cases where there are very large numbers of potential traders. It would be difficult, for example, to issue permits for household waste to individual households, and then record and monitor trades among households (unless a physical ticket was involved). Similarly, holding an auction in such circumstances can also prove to be impractical for cost reasons. Also, in contrast with price instruments, where permits are issued free (rather than auctioned), the government does not raise any revenue with which to cover administrative costs.

6.2.6 Public, private sector and interest group perception

The ability of the Ministry to implement marketable or auctioned permits for environmental protection will depend in part on the degree of support that such policies will have in key public groups, and within the Ministry's regulatory staff. Industry groups have generally been supportive of trading programs, particularly where existing firms are grandfathered (i.e. granted permits for free). Environmental groups have varying views, but would support permit trading in some applications. Overall, the Ministry is less well-versed with tradeable permits approaches than with pricing instruments.

Industry Views

Industries now subject to command and control regulations have generally been supportive of proposals to permit emissions trading, but would oppose the auctioning of emissions permits, for the same cost reasons that they oppose pollution taxes.

Consultations with industry on a proposed trading plan for NO_x and VOCs found "considerable support for such a system," according to Doern (1990). A proposed NO_x-VOCs trading plan developed by consultants to Environment Canada is now under review. This case is also illustrative of a general conclusion reached in other studies, that the method of the allocation of permits creates winners and losers in an industry and thus leads to supporters and opponents among firms. For example, a proposed permit system for solvents would have allocated production quotas to 15 existing producers. The solvent producers therefore supported the program since the effect of the quota would be to bid up solvents prices and their profitability. Solvents *users* would have preferred a system which granted quotas to users, protecting them against entry into their industries. They opposed the trading program for quota among solvent producers due to its impacts on solvents prices.

For acid gas controls, while the major emitters are interested in trading, one respondent felt that the Countdown Acid Rain program might be too far along to permit trading at this point, particularly since purchases of credits by Hydro (where Hydro would undertake less abatement than originally planned in exchange for additional abatement by a metals firm) would face political opposition by environmental groups. However, this same respondent felt that reductions that might be mandated in the future to exceed the Countdown targets, or programs to extend controls to smaller sources, could profitably include provisions for emissions trading. The firms interviewed did not feel that monitoring procedures would have to be significantly altered to allow emissions trading. Note that again, any support for trading is dependent upon the method in which permits are initially allocated. Firms with large current emissions would favour a system that allocated permits proportionally to these levels; firms that had already undertaken abatement efforts (or firms considering new facilities) would oppose this type of allocation.

While agreeing that effluent trading offered some potential for savings, industry representatives differed in their views on the practicality of this approach in the case of controlling BOD levels. The respondents recognized that trading would have to be limited to firms in the same watershed. Some felt that there would be too few possible trading

possibilities as a result of this restriction, although a few examples were cited. Some also expressed the view that a minimum technological standard should still be required (e.g. secondary treatment).

The case study evidence also points to the impact of differing initial allocations for permits in terms of generating winners and losers within an industry. Allocating permits based on current emissions (e.g. 50% of a current base-year level) favours those firms that have lagged behind others in adopting control technologies. The Ministry has recognized the need to avoid favouring such firms in its command and control policies. A parallel approach in a marketable permits system bases the initial shares of permits allocated to each firm on the output of the firm, or on a more distant historical level of emissions.

Environmental Group Views

The three major environmental groups interviewed by Ernst & Young were somewhat less supportive of marketable permits than pollution taxes. There was agreement that permit trading would have to be limited to cases where toxins were non-persistent, but there might be some acceptance of trading as a part of a phase-out program where zero-discharges were not technologically feasible today. Cost savings were not seen as a reason for delaying a move to complete elimination of such toxins by each and every source.

For less toxic emissions, there was some concern that permit trading might convey the notion that a firm has a "right" to pollute, but there would be some support for trading under restricted circumstances. Environmental groups would be more amenable to permits if they were part of a long-term abatement strategy (i.e. permit levels would be continually reduced). One respondent also stressed the need to restrict trades to cases where the relationship between discharges at each source and ambient environmental quality was well understood. Another liked the idea of being able to raise funds to purchase permits for the themselves and thereby reduce total emissions, but felt that, as a public monopoly with the ability to pass on costs, Hydro should be precluded from purchasing additional permits.

According to Doern (1990), the Canadian Environmental Network (CEN), a coalition of environmental groups, was less supportive of tradeable permits (for NO_x and VOCs) than industry groups, but it did agree to support a pilot study of such a system. CEN argued in its brief that "expensive measures (i.e. retrofitting, substitution)[should] not be overlooked in favour of reduction measures which would result in large reduction for less money. The principle of reducing emissions at source still prevails". Interestingly, in

common with some industry views, CEN also felt that there was a need to press for reductions in the U.S. if Canadian reductions are to produce a clear environmental benefit.

Ministry of the Environment Staff Views

As discussed in the case studies, the U.S. experience with emissions trading shows that opposition from within regulatory agencies (in this case, within both the EPA and various state agencies) can lead to a very restrictive trading policy that thwarts the purpose of emissions trading. At this point, it appears that any trading program would have to overcome some resistance from within the Ministry's regulatory staff.

Respondents from the Ministry's Air Resources Branch tended to be philosophically opposed to emissions permit trading on the grounds that it created a "license to pollute." Furthermore, as in the case of emissions taxes, there was a view that monitoring costs would pose a barrier to their application in the case of VOCs, for example. For carbon dioxide, a trading program would be impractical due to the very large number of sources.

For SO_2, there was a feeling that MOE had already taken compliance costs into account by placing a greater burden on the nickel producers than Hydro (which had higher abatement costs). There was also a view that, if permits were for a limited period (say, one year) Inco would be reluctant to continue to sell the same volumes of permits to Hydro during boom periods for the nickel business, forcing Hydro to make unanticipated investments in emissions controls. Trading between large and smaller sources was rejected on the grounds that monitoring costs would be expensive, and because it was seen as easier to focus on the largest four sources. There was also a view that it was easier to maintain a fair competitive playing field between Inco and Falconbridge through command and control than would be the case in an initial allocation of permits for trading.

Doern (1990) reached a similar conclusion on the views of the Ontario Ministry of the Environment with respect to emissions trading for NO_x and VOCs:

> Ontario's Ministry of the Environment was... even more ingrained in the command and control mode of operation than was DOE.... As a senior Ontario environmental official put it to the author: "Our approach is regulatory, plain and simple. We indicate to polluters where we have to be at a point in time." The official went on to stress that "the Canadian expectation is that we will tighten down on every industry." Tradeable permits were not a persuasive option in the environmental culture of the Ontario ministry.

Our two respondents in the Water Resources branch were also not particularly supportive of effluent trading. Several technical complications to such programs were mentioned. These included the need to restrain trades to the same water body (although additional abatement on a river might be exchanged for less abatement on the lake into which it feeds, but not vice versa). The multiple-element nature of effluents would tend to limit trading possibilities. For example, even if BOD or TSS were tradeable, the purchaser of an effluent credit could not be allowed an accompanying discharge of a more toxic substance.

According to these respondents, MISA would have to be changed philosophically to use economic instruments. The current philosophy is based upon making every company reduce as much as is technically possible and economically achievable, while trading or tax approaches would enable some firms to use less than the best-available technology, possibly in exchange for greater reductions elsewhere. It might be possible to incorporate a temporary trading program as a part of the phase-in of MISA requirements, where firms that had been able to surpass a standard could trade with others on the same body of water that were having difficulty in meeting a rapid phase-out schedule, to give the latter a bit more time.

The polluter-pay approach being adopted by the Ministry's Waste Management Branch bears a closer relationship to price instruments rather than to tradeable permits approaches. In practice, an auction of permits with subsequent trading can be used as a substitute approach that preserves the user pay philosophy, but this is likely to prove to be less practical than the use of pricing instruments in most applications. (Indeed, we are not aware of any solid waste applications of marketable permits approaches elsewhere.)

6.2.7 Suitability and effectiveness as public financing mechanisms

Marketable permits allocated free of charge raise no funds for the public sector. An auction of permits raises funds in a manner that can be shown to be identical to pollution taxes in ideal circumstances, and thus the same issues that were discussed in Chapter 5 would apply to the use of auctioned permits for public financing. We therefore refer the reader to Chapter 5 for a discussion of these issues.

6.2.8 Implications for international trade competitiveness

Marketable permits approaches to environmental protection offer important advantages over command and control in terms of their implications for industrial competitiveness. Marketable permits enable firms to trade permits and achieve cost savings, while still meeting targets for environmental quality. The cost savings facilitated by trading translate into an improved competitive position against firms facing less flexible regulatory programs in other jurisdictions. In this regard, the fact that the U.S. is moving towards the use of emissions trading makes it more important that Ontario adopt similar approaches to maintain the competitive position of its utilities and heavy industries.

The major disadvantage posed by permits surrounds the treatment of new facilities. If such entrants are not granted permits, and are forced to purchase all of them from existing suppliers, they will bear higher total costs (for abatement and permit purchases) than they would face under command and control. However, the existing command and control approach in Ontario does not in fact require all new emissions to be offset by reductions from existing sources. Thus, the government could allow for some entry by allocating additional permits to entrants. This could be accomplished without negative environmental impacts by formally setting aside some permits from the initial allocation for future entrants, or by forcing firms selling permits to cede some of these to the government, which would then be reserved for new facilities.

Auctioning of permits raises the same revenues as a pollution tax. We therefore refer the reader to Chapter 5 for a discussion of the implications of such taxes for industrial competitiveness.

6.3 Conclusions

Marketable permits appear to offer important advantages over command and control policies in some circumstances. Permit systems work best where discharges of a similar nature occur into a well-mixed medium, where the objective is to control, but not entirely and immediately eliminate discharges, where there are a reasonable number of potential traders, but not so many as to make trading impractical. Auctioning of permits can be a substitute for pollution taxes, particularly where the latter would be viewed as undesirable due to the uncertainties surrounding the ultimate level of abatement that would result.

Several possible applications of permits appear to be worth further investigation. These include the potential trading system now under study for NO_x and VOCs, the

possible use of trading for additional acid gas reductions beyond those entailed in the Countdown Acid Rain Program, and perhaps some selective applications in controlling BOD and/or TSS where the contaminants are of similar toxicity (e.g. from the same type of industrial plant). Permits trading also has value in terms of controlling the production or use of hazardous substances, such as CFCs. We discuss these issues further at the conclusion of Chapter 7.

7. FRAMEWORK FOR EVALUATING THE APPROPRIATE ENVIRONMENTAL POLICY INSTRUMENT

7.1 Introduction

Chapters 5 and 6, as well as more specific issues explored in our case studies, indicated that on many criteria, each type of policy instrument has strengths and weaknesses. The nature of the environmental problem, the current status of environmental policy, the types and numbers of firms, municipalities or households involved and other factors affect the performance of economic and command and control approaches. Thus, our findings suggest that economic instruments are likely to be favoured over command and control only in some environmental policy applications.

While this has been recognized in the literature, we know of no previous attempt to systematically categorize the factors that should influence the choice of economic or command and control instruments. Other jurisdictions have applied economic instruments on a case-by-case basis, or have developed lists of potential uses for them, rather than more fundamental criteria for their use or rejection. Our review of past applications suggests that there are a number of pitfalls that could have been avoided in selecting the policy instrument used.

In this chapter, we develop a formal framework that can be used by the Ontario government to examine the merits of various instruments for environmental protection. We explore the various conditions that favour the use of particular economic instruments or command and control, based on our findings in the case studies, and on the general conclusions reached in chapters 5 and 6. We then use the problem of ground level ozone to illustrate the application of our framework to the choice of policy instruments.

7.2 Framework for Selecting the Appropriate Instrument

7.2.1 Nature of the Contaminant

Toxicity

Where the contaminant being controlled has been found to be highly toxic in very small quantities, and an immediate and complete elimination of discharges is required, command and control programs offer the most effective approaches. For example,

product bans have been imposed, albeit only rarely, where new information has indicated major human health concerns. Although in practice an immediate an complete ban is often unachievable, from a political perspective, one would not wish to acknowledge a phase-out in the design of the program.

As a long-run policy, economic instruments generally are not useful as the sole means of ensuring zero discharges. The primary use for economic instruments in such cases is as a supplement to command and control. A heavy pollution tax can be placed on discharges, as an incentive to compliance with control orders. This may be a more practical mechanism of penalizing dischargers than the use of of prosecution through the courts.

Both command and control and economic instruments can be effectively applied where the objectives are for less-than-complete elimination, or where there is a phase-in period towards such elimination (during which discharges will be allowed). In many cases, even where a discharge is of fairly high toxicity, an immediate ban is unachievable, and thus a phase out period will be required. Economic instrument approaches are likely to face resistance from environmental groups in such cases, who may not recognize the ability of these instruments to permit a more rapid phase-out schedule.

Linear Damage vs. Threshold Effects

Environmental contaminants differ in the way in which increases in discharges result in damage to human, plant or animal life or to property. In many cases (e.g. household waste, dispersed acid gas emissions, carbon dioxide, CFCs, some carcinogens) increasing discharges result in continually increasing damage, in a roughly linear fashion. Other pollutants are thought to impose damages only or primarily beyond a certain threshold.

Contaminants with fairly linear damage functions can be controlled by either command and control or economic instrument approaches. Environmental objectives for the pollutants subject to threshold effects entail keeping ambient levels of the contaminant below a given threshold. This can restrict the use of economic instrument approaches to some extent:

- Effluent charges or taxes do not provide the certainty over discharges need to maintain ambient levels below a threshold over time. They may still be used as a supplement to command and control policies in such circumstances, where there are still some costs to discharges when

ambient quality is better than the target threshold, in order to provide incentives for additional abatement;

- Tradeable permits could still be used, *provided* the environment was well mixed. The total level of discharges permitted would have to be designed to achieve the ambient target.

Such threshold effects also pose complications for some command and control approaches. A single technology-based standard will not necessarily ensure that ambient levels remain below a target if there are local concentrations of sources in some areas of the province, or if economic growth increases the number of sources in a region. Source-specific control orders are needed to match the levels of emissions at each source with the target for ambient water or air quality.

Seasonal and Other Variability in Damage

Some pollutants, including BOD in water and emissions promoting ground level ozone problems, are subject to seasonal variations in the damage done for a given volume of discharges. Air pollutants are also subject to shorter term fluctuations in damage based on weather conditions.

All types of instruments can be adjusted to deal with seasonal effects, although command and control and tradeable permits are likely to do so more predictably than price instruments. Where there are seasonal effects that are reasonably predictable, tradeable permits can set varying discharges by season. Pollution taxes can have rates that vary by season. Command and control approaches can set varying standards by season where necessary, although this is rare in practice. For pollution "episodes", one might still need a command and control instrument to override tradeable permits or supplement pollution taxes on a temporary basis.

Homogeneity Across Sources

Some environmental discharges, including sulphur dioxide and carbon dioxide in air, and mercury in water, for example, are emitted in the same form by different sources. In other cases, a class of discharges subject to control, such as VOCs in air or BOD in water, differ in their chemical composition and environmental impact.

Economic instrument approaches offer their greatest advantages in terms of the simplicity of the regulatory development process where the discharges from each source are very similar in terms of their environmental impact. Both permits and pollution taxes

allow the market to substitute reductions at different sources, which would, in the absence of adjustments, be inappropriate for non-equivalent discharges.

Permits and taxes can be adjusted to allow for differences in damages per unit of discharge. For example, trading ratios other than one-to-one were established for different ozone depleting substances in the U.S. Different tax rates could be imposed on each type of VOC. However, the greater are the differences in the nature of contaminants and the more numerous the individual types of contaminants there are, the greater will be the complexity of such systems.

Heterogeneous discharges also complicate the establishment of appropriate standards in a command and control system, since standards should be set to vary with the damage done by each different type of discharge. However, command and control approaches already entail a detailed consideration of each source in the setting of control orders, even where the discharges are identical. The impact of heterogeneity in the discharges is thus the loss of an advantage that economic instruments otherwise have in terms of the speed and rapidity of the regulatory development process.

Linkage to Production or Consumption

Taxes and charges placed directly on the production or consumption of a given good or service are most appropriate as a means of environmental policy where environmental damage is inextricably linked to the use of a product. Where environmental damage is primarily dependent upon the nature of the use and/or other environmental protection efforts (e.g. care is disposal, etc.), these mechanisms are less well-suited than either deposit-refund or non-price approaches.

7.2.2 Nature of the Environmental Medium

Mixing

The medium into which discharges occur can be classified according to the degree to which discharges from individual sources are mixed. The extreme of a well-mixed medium is the case of global emissions of CFCs and halons or greenhouse-effect gases, where a given volume of emissions from any geographic location contributes equally to the global environmental problem. Extremes for an unmixed case would involve very localized noise or odour problem, where a single source accounts for the problem and local damages are unrelated to activities in other locations.

Economic instrument approaches, other than deposit refund, are best suited for cases where the environmental medium is well-mixed, for the reasons outlined in Chapter 5. Where it is mixed only within a certain airshed or water body, then economic instruments require that the area of mixture contain at least two sources, and preferably several.

Where mixing is highly imperfect, or where each source contributes to an individual local pollution problem, command and control approaches that set standards for each source based on local environmental quality are best able to ensure the protection of the environment at each location[105]. Deposit-refund systems are an exception, since they can be used, for example, to prevent litter at differing locations, or to ensure firms meet certain performance requirements, particularly where the deposit is set high enough to promote near-universal compliance and where the damage per unit of remaining discharges is small.

Transboundary Flows

Where transboundary pollution is a problem, and the environmental medium is not perfectly mixed, the trade-offs engendered by economic instrument approaches can pose political difficulties. Some trade of emissions permits, for example, could leave total discharges constant, but worsen the transboundary flow of pollution to another jurisdiction. If the government is sensitive to preserving cooperative relations with the other jurisdiction (perhaps to control transboundary flows into the province), it may wish to avoid the use of economic instrument approaches in such cases, or at least place restrictions on trades that worsen transboundary flows.

[105]The problem with economic instruments in such cases need not associated with a violation of rules for *economic efficiency* (minimizing the total cost of achieving a given total benefit from abatement.) In an unmixed environment, if all receptors (e.g. individuals downwind of a set of smokestacks) are equally sensitive, and if the damage funtion is linear (damage done to each receptor increases lineraly with total discharges), then the conditions for economic optimality (constant ratio of marginal benefits of abatement to marginal costs of abatement) will not be violated with economic instrument approaches. However, from an *equity* standpoint, such approaches will have shortcomings, since emissions trading or pollution tax approaches could significantly worsen the health of some individuals in exchange for gains for other individuals.

7.2.3 Nature of Abatement Costs

Cost Differentials Across Sources

The efficiency gains that economic instruments can realize over command and control programs are linked to differences in marginal abatement costs across sources. Thus, either price instruments, auctioned permits or tradeable permits offer the greatest advantages where abatement cost conditions differ widely across sources.

Magnitude of Abatement Costs

Where abatement costs are very high, pollution taxes must be set at very high rates in order to provide sufficient incentives for firms to be willing to undertake abatement efforts. (The high rates may not be a problem in terms of the resulting tax burden where the desired rate of abatement entails removing nearly all of the discharges, since the high tax rate necessary to induce such abatement may be outweighed by the low level of remaining discharges on which pollution taxes must be paid.) As discussed in Chapter 5, political realities, as well as concerns over industrial competitiveness impacts, often preclude the setting of very high pollution tax rates in practice. Similarly, in such circumstances, the market price of auctioned permits is likely to be very high, leading to similar competitiveness problems for firms.

Thus, where abatement costs are sizable relative to industry profits and desired abatement will leave significant continuing discharges on which pollution taxes would be paid, marketable permits or command and control approaches are favoured over price instruments, particularly pollution taxes. Charges which raise funds that are used to subsidize abatement costs by the industry, or pollution taxes that substitute directly for other taxes on the same industry, can also be used in such circumstances.

High abatement costs may also favour marketable permits over command and control. The greater are the abatement costs, the more likely are there significant savings achievable through permit trading that might justify any additional administrative costs entailed in allowing this flexibility.

Certainty of Abatement Costs

The response to a pollution tax is directly dependent upon abatement costs. Where these are not well-understood by the regulator, setting a pollution tax to reach a desired

level of abatement will prove to be difficult. Adjustments to such taxes could lead to conflicts between environmental goals and revenue targets set by the Ontario Treasury. Thus, where abatement targets are known, and abatement costs are unknown, the regulator should favour the use of either command and control or marketable permits approaches over pollution taxes. Pollution taxes would be more suitable as a supplement to command and control in such cases.

7.2.4 Nature of Abatement Technology

Regulator's Knowledge of Technologies

Economic instruments will be favoured over command and control where it is costly for the regulator to remain fully-informed on all of the available control technologies. This is the case for several reasons:

- a knowledge of technologies is necessary if command and control regulations are to be based on a "best available technology" approach. The development of this knowledge base can be a time-consuming process that results in delays in setting standards and achieving abatement;

- pollution taxes or tradeable permits can be used where the regulator is uncertain as to whether the available technologies are applicable to all sources, since firms that cannot use them can purchase permits from others or pay the pollution tax, while others will adopt the technology;

- Economic instrument approaches encourage the regulator to monitor performance rather than merely ensure the application of a given technology. Command and control can offer monitoring savings if the mere use of a technology guarantees that an abatement standard will be achieved, but the extent to which it is exceeded is difficult to measure.[106] This would not be the case where the regulator lacks the knowledge to translate technology usage into discharges with sufficient certainty.

[106]Don Dewees (personal communication, May 1991) points out that one can design economic instrument approaches that also entail the monitoring of only the technology employed by the firm, with the technology installed and the firm's output being translated into an estimate for emissions. Such methods have been used for relatively minor water effluent charges in some jurisdictions, where these are a supplement to command and control. Our view is that at the high pollution tax rates or strict tradable permit levels needed in a system that relied solely on economic instruments, the imprecision of these estimates would undermine the approach. It would also be difficult in situations with numerous possible technology responses, precisely the conditions that make economic instruments attractive for their flexibility in firm responses.

Homogeneity of Appropriate Technology

Command and control regulations are best suited for cases where there is limited or no choice with respect to the appropriate abatement technology, and all sources are likely to adopt the same approach. Such cases offer the least chance of improper best available technology standards, and speed the process of setting such standards. Conversely, economic instrument approaches offer economic efficiency gains through trading or flexible response among source, and speed advantages in setting the control instrument, where there are numerous sources with many different technological options.

Importance of Technological Change

Where technological change has the potential for significant improvements in abatement costs or effectiveness over time, the chosen environmental policy mechanism should provide appropriate incentives for research and development.

As discussed in Chapters 5 and 6, some of the theoretical arguments suggest that economic instrument approaches provide greater incentives for environmental R&D, since firms have a direct economic incentive to uncover new methods of avoiding pollution taxes or generating discharge permits for sale to the market. Empirical evidence is lacking on this issue. We also found that a command and control performance target set with a long lead time can encourage R&D by firms seeking methods of compliance.

Technology-based standards setting can also encourage research by environmental protection goods and service suppliers, who can then use government regulators to compel industry to adopt any more effective technology they develop. In practice, however, environmental industry participants have been critical of governments using technology-based standards for being too conservative in permitting or requiring the use of new, innovative approaches with which they are less familiar.

Thus, we conclude that, where long lead times are not feasible due to environmental concerns, and R&D by the regulated firms is important, economic instruments are favoured over command and control. Long lead times for performance standards under command and control can be used to create a window of opportunity for R&D. Alternatively, the government can use a technology-based command and control policy to promote research by environmental product suppliers, but the policy must ensure that the government will be open to requiring such new technologies as these are uncovered.

Continuous or Discrete Abatement Options

Some pollution problems can be dealt with only using discrete technological changes that lead to large, discontinuous drops in discharges. Others have technologies for abatement that offer a nearly continuous range of options for discharge levels.

Pollution problems dealt with solely by discrete policy choices are less suitable for economic instrument approaches that those with a continuous range of discharge possibilities. First, where choices are discrete, firms in a command and control program are likely to surpass a given discharge standard in terms of the degree of abatement. Under a marketable permits approach, they would be generating credits for the sale to other firms as a result of this performance, enabling other firms to exceed the standard. The result is a greater level of emissions in total that under command and control.

Second, under a pollution tax program, firms are best able to respond to the incentive impacts of the tax if there are a range of marginal abatement steps available (e.g. low cost steps which might take them beyond a treatment level imposed by a standard). If there are only very discrete discharge levels possible, pollution taxes may not result in any additional abatement beyond a straight technology-based command and control program.

7.2.5 Nature of Monitoring Technologies

As discussed in previous chapters, while economic instruments have been criticized for requiring more extensive and costly monitoring, applications in other jurisdictions have often relied on the same monitoring approaches as used under command and control. Self monitoring and reporting, or occasionally the use of estimated emissions based on production volumes and technologies employed, can be used to set rates for pollution taxes or to determine the firm's compliance with discharge permits, just as they are used to enforce command and control regulations. Pollution taxes can be designed to exempt firms with discharges below a certain level in order to avoid monitoring smaller or very clean sources.

There may still be some cases where economic instruments could be undesirable as a result of high monitoring costs. Some environmental problems only require that discharges or ambient levels be held below a certain threshold. In these cases, monitoring of individual sources is then not necessary on an ongoing basis as long as ambient quality is within acceptable levels, and enforcement may be restricted to initial technology

approvals. In such cases, where ongoing monitoring would prove to be very expensive, economic instruments may be less appropriate than command and control. This should only be the case where there is little or no value attached to improving emissions beyond the threshold level relative to the economic costs of monitoring.

7.2.6 Nature of Regulated Polluters

Number of Sources

Pollution taxes can work well for a very small number of sources, but pollution taxes or deposit-refund systems are particularly well suited for influencing the behaviour of very large numbers (thousands or more) of pollution sources, where either marketable permits or command and control would prove to be impractical. For example, where the objective is to reduce consumption by households of individual products, a tax on such products is an effective single policy instrument that will generally be less costly to administer than quotas on producers or consumers. Deposits can create incentives for millions of households to return containers in a way which could not be achieved under command and control. Command and control approaches, such as anti-littering laws and fines, tend to be unenforceable.

Marketable permits systems work well with more modest numbers of traders, but requiring more than one or two sources to work effectively. Command and control approaches work well for either single source problems (e.g. localized pollution problems) or for modest numbers of sources, but become cumbersome and time consuming where standards must be set and enforced for hundreds of sources.

Exposure to Out-of-Province Competition

Pollution taxes can pose competitive problems where rates must be high to provide incentives for abatement efforts, and where the firms must compete with firms in other jurisdictions that do not face such taxes.

Minimizing impacts on industry output, even where the industry is responsible for environmental costs, is generally an objective for environmental policy-making. Thus, other price instruments (charges with funds reallocated to the same industry or deposit-refund) marketable permits, or command and control, will be favoured over pollution taxes where there is tough competition from outside jurisdictions.

Where another jurisdiction with competing firms adopts a marketable permits approach, competitive conditions may favour allowing such discharge trading in Ontario. Otherwise, firms in a particular industry that is generating revenue from the sale of permits, or reducing costs by purchasing permits, will gain a competitive edge over Ontario firms facing less flexible regulatory requirement in a command and control system.

Subsidies for pollution control could conceivably be challenged as a trade-distorting measure by the U.S. or countries. However, in practice, most jurisdictions offer some support for such investments, and Ontario is not likely to face difficulties if the subsidies are offered through tax concessions, low interest loans, or other less direct means.

Marketable permits (non-auctioned) may be undesirable where there are little competition in the industry from outside the province *and* only a few in-province sources of the pollutant that are all in the same industry, for the reasons discussed under "Monopoly Power" below. Issuing permits free to existing firms will create a barrier to entry for new firms, and could enhance monopoly power in such industries. Shorter-term permits, or reserving permits for new entrants, are possible solutions to this problem.

Industry Financial Condition

For similar reasons as cited above, an industry in weak financial condition may be a less suitable target for pollution taxes than other forms of environmental regulation, due to the added costs that pollution taxes pose. Where only a few firms are in difficulties, pollution taxes can be designed to include exemptions for firms in financial distress, subject to some appropriate conditions on their level of abatement. Marketable permits may be favoured over command and control for industries in financial difficulty, since the cost savings achievable with a more flexible instrument may enable tougher overall abatement objectives while minimizing industrial dislocation.

Public and Private Sector

Economic instruments may *in some cases* be less well suited for applications to public sector bodies. Ontario Hydro, as a public utility, could be included in trading or pollution tax programs, although some environmental groups would oppose trading programs that would permit Hydro to undertake less than best available technology measures, on the grounds that they can pass on costs to their consumers. A tax imposed on municipalities or local hydro authorities on their purchases of water or electricity could

be deemed to be an indirect tax outside provincial jurisdiction. However, municipalities or hydro authorities could collect such taxes on water and power users.

Relationships Among Polluters

Marketable permits tend to work best in situations where polluters are already involved in inter-firm transactions, as was the case in the U.S. lead trading program. This is not an essential condition, but one which aids in establishing an open market for permits.

Economic Growth in Polluting Industry

Quantity-based economic instruments, in contrast to source-specific command and control or price approaches, directly confront the relationship between economic growth and environmental quality. A tradeable permits system forces the regulator to decide the extent to which, if at all, economic growth should be allowed to increase the overall level of discharges. Furthermore, it allows economic growth to take place in a region where ambient levels are not currently below a desirable standard, by enabling an entrant to purchase added abatement from existing firms (rather than merely blocking entry on the grounds that the new firm would add to total emissions). Thus, to the extent that industrial growth is an environmental threat even if individual sources meet best technology standards, marketable permits approaches are favoured.

Shorter-term permits, with reallocations or auctions of additional permits over time, are better able to accommodate economic growth than a single long-term issuance of permits to existing firms, which favours such firms over new entrants. Existing firms also tend to be favoured over new entrants under command and control programs, which often impose tougher new source standards.

Monopoly Power

Industries with significant monopoly power – those with few domestic or foreign competitors that therefore have the ability to control prices – can potentially pose problems for the workings of economic instrument approaches.

Marketable permits (non-auctioned) may be undesirable in such circumstances since issuing permits free to existing firms will create a barrier to entry for new firms, and could enhance monopoly power in such industries. Shorter-term permits, or reserving permits for new entrants, are possible solutions to this problem. Furthermore, the problem does

not arise if there are a significant number of permit holders in other industries that could trade with new entrants in the monopolized industry.

Pollution taxes or product charges tend to raise the price of a product. This is generally desirable from an economic efficiency standpoint if the production or consumption of the product is associated with environmental "externalities" (damage borne by others). However, where the product market in question is already a monopoly or oligopoly, the price would have already been elevated above competitive levels due to the exercise of monopoly power by the firms in the industry. Thus, in such cases, the addition of a pollution tax or product charge can in some cases reduce economic efficiency, by raising the price of the product beyond the point justified by the environmental damage it causes.

7.2.7 Nature of Existing Regulatory Climate

Jurisdiction

Some pollution problems are not strictly in the domain of provincial policy. These include pollution problems dealing with waterways subject to federal regulations, and municipal waste management issues that come under local government jurisdiction.

Marketable permits or command and control policies developed by Ontario can have difficulties in these instances, due to the lack of clear provincial jurisdiction, unless instituted in collaboration with another level of government. For example, permit trading can be impeded if firms fear that trades could be invalidated by federal regulations that prevent permit purchasers from having higher discharge levels. However, pollution taxes or subsidies may be more readily applied in such circumstances, since there are fewer restraints on what the province is able to tax or subsidize.

Extent of Existing Body of Standards

Regulatory change typically imposes administrative costs for both governments and regulated industries. Thus, where an existing system of command and control regulations is well-developed *and is functioning well,* one would be less inclined than in new areas of environmental policy, or areas where command and control has failed, to recommend a shift to economic instruments. This is also consistent with our finding that economic instruments have worked best when adopted at the outset of environmental policy in a particular area, rather than being grafted on to an existing command and control policy.

Economic instruments might still be considered as a supplement to command and control in such cases. Limited emissions trades could be permitted to save on abatement costs while retaining most of an existing command and control framework. Pollution taxes or charges could be used to provide an incentive to surpass existing command and control standards, or as an automatic fine on exceedances of command and control levels.

Extent of Industry Resistance

Command and control policies have in the past been criticized as a result of the ability of industry to win delays or adjustments to environmental standards. Since they entail less of a negotiation process, and have some built-in flexibility in the responses of individual firms, economic instruments will be favoured where governments wish to establish firm targets and minimize opportunities for individual firms to seek adjustments or delays. This is particularly true for marketable permits, which set a clear overall target for discharges. Pollution taxes, charges or deposit rates are more subject to ongoing industry lobbying, particularly since inflation implies that they must be constantly increased in order to maintain their real value.

On the other hand, for political reasons, the government may in some cases favour a more consultative, one-on-one approach to standards setting. In such cases, a command and control approach offers greater opportunities for being sensitive to the circumstances of individual firms. Firms that have benefitted from lenient treatment under command and control approaches relative to their competitors are likely to oppose moves to the more uniform approach entailed in economic instrument methods.

Knowledge of Existing Discharges

Marketable permit systems require the regulator to set an initial allocation of discharge permits among the sources being regulated. In order to avoid firms generating credits for reductions that never took place, it is necessary to have a clear picture of emissions at each source prior to the program.

7.2.8 Nature of Other Policy Objectives

Desire to Promote Conservation or Affect Industry Output

In contrast to the discussion in Section 7.4, there are some cases where government objectives would include a desire to reduce economic activity in some areas, to promote

resource conservation or to avoid pollution problems that are inherent in a given type of activity. In such cases, economic instruments will be favoured over command and control, since they create direct incentives for a firm to reduce pollution through output reductions. A firm can generate discharge credits for sale under a marketable permits approach through an output reduction or shutdown. Similarly, pollution taxes will tend to raise prices and lead to lower levels of industry output.

Government Fiscal Policy Objectives

The province may have non-environmental policy objectives that can affect the selection of the appropriate environmental policy instrument. In particular, for various reasons, Ontario may wish to adopt instruments that incorporate the "polluter-pay" principle, and use pollution taxes or auctioned permits as a means of raising government revenues.

Chapter 5 already reviewed the strengths and weaknesses of pollution taxes as a revenue source. Where existing taxes are posing large inefficiencies, pollution taxes will be an attractive substitute source of revenue, and could be politically attractive if implemented as a direct replacement for an existing tax on the same sector.

Fiscal policy objectives can also affect the desirability of the use of another price instrument: subsidies for environmental protection costs. Where subsidies would have to be high to promote abatement, they may be undesirable from a budgetary deficit perspective.

7.3 Applications of the Framework

7.3.1 Summary Table

Table 7.1 provides a summary of the characteristics examined above and their implications for the appropriate choice of policy instruments. A "P" indicates that the presence of that characteristic has a positive impact on the operation of a particular instrument. An "N" indicates a negative impact on that instrument, while a 0 indicates that its presence is neutral in its impact.

These do not necessarily correspond to comparisons across instruments. For example, a given characteristic may be helpful in making a trading system work (e.g. existing transactions among firms) but does not imply that marketable permits will be better

Table 7.1

Framework for Selecting Environmental Policy Instruments

		Taxes	Charges	Deposit-Refund	Marketable Permits	Auctioned Permits	Command and Control
Nature of Contaminant							
Toxicity	Extremely High	N#	N#	N#	N#	N#	0
	Other	0	0	0	0	0	0
Damage	Linear	0	0	0	0	0	0
	Threshold	N#	N#	N#	?	?	?
Variability	Seasonal Damage	N#	N#	N#	N	N	N
	Episodes	N#	N#	N#	N#	N#	0
	Constant Damage	0	0	0	0	0	0
Homgeneity of discharge	Variable across sources	N	N	N	N	N	0
	Similar	0	0	0	0	0	0
Prod'n-Cons'n/Damages	Closely-linked	P	P	0	0	0	0
	Not Closely Linked	N#	N#	0	0	0	0
Nature of Medium							
Mixing	Well Mixed	0	0	0	0	0	0
	Localized	N#	N#	0	N#	N#	0
Transboundary Flows	None	0	0	0	0	0	0
	Significant	N#	N#	N#	N#	N#	0
Nature of Abatement Costs							
Cost Differentials by Source	High	0*	0*	0*	0*	0*	N
	Low	0	0	0	0	0	0
Magnitude of Costs	High	?	?	0	0	?	0
	Low	0	0	0	0	0	0
Certainty of Costs	Certain	0	0	0	0	0	0
	Highly uncertain	N#	N#	N#	0	0	0
Nature of Abatement Technology							
Regulator's Knowledge	High	0	0	0	0	0	P
	Low	0*	0*	0*	0*	0*	N
Homogeneity Across Sources	High	0	0	0	0	0	P
	Low	0*	0*	0*	0*	0*	N
Techn. Change by Polluters	Important	0*	0*	0*	0*	0*	N
	Unimportant	0	0	0	0	0	0
Abatement Options	Continuous	0	0	0	0	0	0
	Discrete	N	N	N	N	N	0
Nature of Monitoring Technology							
Cost	High + Damage Threshold:	N#	N#	N#	N#	N#	0
	Other	0	0	0	0	0	0

Table 7.1

Framework for Selecting Environmental Policy Instruments

		Taxes	Charges	Deposit-Refund	Marketable Permits	Auctioned Permits	Command and Control
Nature of Sources							
Number	Very Large	P*	P*	P*	N	N	N
	Several	0	0	0	P	P	0
	One or Two	0	0	0	N	N	0
Out of Province Competition	High	0#	?	?	P*	0#	0
	Low	0	0	0	?	0	0
Financial Performance	Strong	P	0	0	0	P	0
	Weak	N#	?	?	0*	N#	0
Sector	Public	?	?	?	0	?	0
	Private	0	0	0	0	0	0
Interfirm Linkages	Frequent transactions	0	0	0	P	P	0
	Infrequent transactions	0	0	0	N	N	0
Economic Growth	Important	0	0	0	0*	0*	0
	Unimportant	0	0	0	0	0	0
Monopoly Power	High	?	?	0	?	0	0
	Low	0	0	0	P	P	0
Nature of Existing Regulations							
Jurisdiction	Ontario only	0	0	0	P	P	P
	Shared	0*	0*	0	N	N	N
Existing Body of Standards	Extensive, effective	N#	N#	N#	N#	N#	P
	Non-existant or ineffective	0	0	0	0	0	0
Industry Resistance	Strong	N#	?	?	0*	N#	N
	Weak	0	0	0	0	0	0
Knowledge of Discharges	Strong	0	0	0	0	0	0
	Weak	0	0	0	N#	N#	0
Nature of Other Policy Objectives							
Conservation objective	Yes	P*	?	?	P*	P*	N
	No	0	0	0	0	0	0
Revenue objective	Yes	P*	?	0	0	P*	0
	No	0	0	0	0	0	0

Legend:

P = charactersitic has a positive impact on the operation of this instrument
N = characteristic has a negative impact on the operation of this instrument
0 = characteristic has no impact on the operation of this instrument
* = characteristic favours this instrument over command and control
# = characteristic unfavourable for this instrument relative to command and control
? = impact of this characteristic can vary depending on other circumstances

than command and control where the characteristic is present. A '*' is used to indicate that a characteristic tends to imply that a particular instrument is favoured over command and control, while a '#' implies that an instrument would tend to be inferior to command and control as a result of the characteristic.

The reader is cautioned that this table should not be used without reference to the remainder of this chapter. In particular, the table addresses each of the instruments in isolation. As we note in the text, the use of combinations of instruments – using command and control restrictions on permit trading, or taxes as a supplement to minimum command and control standards – can eliminate or reduce some of the problems that arise in the use of a single approach in isolation. Thus, a negative score on a particular criterion for a given instrument need not rule out its use.

The framework is perhaps more easily understood by reference to a particular example. In the next section, we use the issue of NOx and VOCs control to illustrate the potential use of our framework in future environmental policy decisions. Following this illustration, we review other environmental issues and highlight some of the considerations that the framework would suggest are relevant to the choice of policy instruments.

7.3.2 Application to NOx and VOCs Control

Ground-level ozone, formed by the reaction of NOx and VOCs in sunlight, is currently one of the most important air pollution problems to be addressed in Ontario. The Canadian Council of Ministers of the Environment (CCME) adopted a Management Plan for the control of VOCs and NOx in 1990, calling for a phased program of controls and reductions to the year 2005.[107] The CCME plan included a recommendation ("Initiative S309") for further study of a NOx and VOCs emission trading program, which would be used within limited geographic regions for the control of emissions from existing stationary sources. In response to this recommendation, Environment Canada has commissioned an ongoing study of the potential for the use of marketable permits for the control of NO_x and VOCs.

In the United States, a U.S. EPA (1991) report recommended that fees on VOCs emissions from major stationary sources should be considered as a supplement to

[107]Canadian Council of Ministers of the Environment (1990), *Management Plan for Nitrogren Oxides (NOx) and Volatile Organic Compounds (VOCs)*, Phase I.

command and control standards in regions that remain non-compliant with ambient targets set for the year 2005. The same report also considered the use of fees or auctioned permits among distributors and retailers as a means of reducing consumer and commercial usage of solvents.

In the following section, we examine how regional NOx-VOCs emissions from stationary sources might score on each of the criteria used in the framework, and the implications for alternative policy instruments. ***We have not undertaken the detailed examination that would be necessary to reach conclusions on the appropriate policy responses in this case. Rather, the analysis is merely intended to be suggestive of the process that Ontario could pursue in exploring policy options using the framework.***

We consider only the aspects of NOx-VOCs controls linked to the control of ground-level ozone. As the CCME report notes, the direct toxic effects of certain VOCs are a further environmental problem, which will be managed through different federal and provincial initiatives.

Toxicity

NOx and most VOCs emissions into the atmosphere would not pose such extreme toxicity risks to require either an immediate or complete elimination of the discharges. This has a neutral impact on the selection of policy instruments.

Damage

In their contribution to ground-level ozone problems, NOx and VOCs emissions are not subject to any sharp threshold effects that would make control through an economic instrument approach difficult, based on the description in the CCME report. While a Canadian maximum acceptable ambient level (82 ppb) has been set, we understand that there is no real cut-off level at which health or vegetation effects worsen sharply, particularly since people appear to differ in their health sensitivity to ozone levels. Thus, this factor has a neutral impact on the selection of policy instruments.

Variability

Ozone problems are related to sunlight, and concentrations are much higher in Ontario during the summer. Both the higher average levels during the summer, as well as shorter-term episodes in the summer months, are considered to be important environmental problems. Relying solely on economic instrument approaches would likely result in excess controls (excessively high emissions charges or low permit levels) relative to the need to control peak ozone levels, reflecting the negative impact relative to command and control indicated in the framework table. However, by retaining some command and control elements, such as the rights to impose emergency orders on major sources during short term episodes, this problem could be alieviated. For seasonal variability, one could

design permit or charge levels that varied with the seasons. However, in practice, even command and control approaches are not likely to incorporate seasonal variations in stringency.

Homogeneity of discharges

Each tonne of NOx within a given region on a given day would be equivalent to other tons emitted in the region in terms of their impacts on ground-level ozone. Homogeneous emissions are neutral in terms of the selection of instruments.

The chemical content of VOCs, however, differs widely across sources. For the control of ground-level ozone alone, this would not pose an insoluble problem for economic instrument approaches, since both permit levels or emission charges could be set based on the reactivity of the VOCs involved. This is similar to the variations in emission entitlements associated with the U.S. trading program for CFCs and halons, where the value of the permit (in terms of the volume of emissions) varies according to the specific CFC or halon involved. One might want to limit trading between NOx and VOCs, in view of the management plan conclusion that each needs to be controlled to achieve ambient objectives effectively.

The variations in VOC content could mean that meeting other objectives (aside from ozone control) for VOC control (e.g. control of specific VOCs known to be carcinogenic or neurotoxic) would require command and control policies that might restrict pollution trading or flexible responses to emissions taxes. This is an area that would need further study.

Production / Consumption Link to Damages

For a number of sources of VOCs, it is the mere consumption of a product (paints, solvents, etc.) that is a source of the environmental problem, in addition to the way in which the product is used. The price increases caused by pollution taxes on the use of such products would therefore be a desirable impact in some cases, by encouraging reduced consumption or searches for alternatives.

Mixing

Ozone problems generally occur in regional airsheds with a reasonable degree of mixing of the individual emissions that create them, albeit in a complex fashion. We understand that it might be necessary to restrict emissions trading to within, say, three or four regions in Ontario in order to avoid local ozone problems being worsened by inter-regional trading. Similarly, one might have different emission tax or charge rates in a price-instrument system, or different standards in a command and control system, for regions with particularly severe ozone problems. Thus, the mixing of the air would not appear to favour one method of regulation over another.

Transboundary Flows

Transboundary pollution flows are apparently important in ozone problems in the Windsor to Quebec City area, based on meteorological data examined by the CCME. Much of the flows are from the U.S. into Canada. However, since the Hamilton-Toronto area is a potential source of ozone problems in Montreal, there would be a need to restrict emissions trades between, say, a source in Toronto and one in Southwestern Ontario that did not affect Quebec ozone episodes. In addition, there is a need for Canada to ensure that

emissions trading would not result in transboundary flows from Ontario to the U.S. that would be in violation of our obligations under the Convention on Transboundary Air of 1979. However, this would not appear to add a further impediment to the use of economic instruments in this case, since trading or emissions charges would have to be set up on a regional (sub-provincial) basis in any event due to the lack of full inter-regional mixing.

The NOx Protocol, signed by Canada in 1988 calls for standards requiring the "best-available technology economically feasible" on new sources. This could preclude the inclusion of new sources in an emissions trading approach, which allows some sources to exceed best available technology emissions in exchange for greater reductions by other sources. Emissions taxes could be placed on new NOx sources, but they would still have to be supplemented by a command and control program requiring best-available technology if Canada's NOx Protocol obligations are to be met.

Cost Differentials by Source

We do not have the data necessary to fully estimate the differences in marginal control costs for the various sources of NOx or VOCs. It appears likely that, in view of the diversity of the sources of both NOx and VOCs, and the variety of control options that are available, there are probably significant differences in marginal abatement costs for both NOx and VOCs. The initiatives suggested in the Management Plan show wide variations in terms of the cost per tonne of reduction achieved. These differences suggest that economic instrument approaches to achieve overall abatement cost savings over less flexible, technology-based command and control approaches.

Magnitude of Costs

Again, we do not have all of the cost data necessary to assess this criterion. It may be that some sectors would face high costs of reducing either NOx or VOCs emissions, and that a pollution tax or auctioned permits approach would impose too heavy an additional financial burden on these sectors if the rates of tax or permit levels are to be sufficiently stringent to meet abatement targets. However, this would not preclude the use of taxes or charges as a supplement to command and control.

Certainty of Costs

The required rates for pollution taxes or charges, such that abatement targets for NOx and VOCs would be met, would be quite difficult to calculate in view of the uncertainties surrounding abatement costs. This would suggest that instruments that directly focussed on quantities (trading or command and control approaches) would be favoured. It might be possible to use taxes where abatement methods are less likely to be one-time investments (e.g. attempts to encourage shifts away from certain solvents), where the need for changes in rates to find the appropriate incentive level would not be intolerable.

Regulator's Knowledge of Abatement Technologies

We have not identified the extent to which the regulator's knowledge in this case would be a barrier to effective command and control methods. There are a wide range of control options for both NOx and VOCs, but the CCME Management Plan does not appear to raise concerns regarding the ability of regulators to develop command and control, best-available control technology standards for new sources in the first phase of the plan. In later phases, it may be that options for advanced combustion technologies, materials

substitution and so on will change too rapidly for effective use of technology-based standards for all sources.

Homogeneity Across Sources

VOC emissions come from a very wide range of sources, including vehicles, paints, solvents, gas distribution and so on. Some NOx emission sources share common characteristics and likely involve similar control technologies (e.g. energy conservation and efficiency improvements for NOx reductions), but there may be a diversity in the optimal mix of responses in terms of energy conservation, fuel substitution and so on. The heterogeneous nature of the sources suggests that a more flexible policy instrument, such as economic instrument approaches, would enable cost savings over command and control policies. At a minimum, command and control approaches could be designed to enable each source to select its method of abatement.

Technological Change by Polluters

A technology-based standard would fail to promote research by polluters, which in the NOx-VOCs case might be important for developing new, cost-effective methods of abatement. Many of the sources for both NOx and VOCs (e.g. paint and solvent manufacturers and users, vehicle manufacturers, power generators and users) are likely to be the best positioned to develop such technologies or substitute products. Economic instruments would create ongoing financial incentives for further research by these firms.

Abatement Option Continuity

Except for fuel substitution, which may create discontinuous changes in NOx emissions, most of the control options appear to offer the continuous range of possible emission reductions that help to create opportunities for gains from emissions trading or marginal responses to pollution taxes and charges.

Cost of Monitoring

It would not appear to be excessively costly to conduct the monitoring necessary for emissions trading or price instruments for large industrial sources of NOx and automobiles (which can be "monitored" based on tests of each model design, or tested periodically once in use as is the case in some U.S. states). At the other extreme, some fugitive emissions of VOCs might be difficult to estimate for a trading or pollution tax program.

Number of Sources

There would appear to be a several major stationary sources of NOx in Ontario that would be sufficiently close geographically to permit an emissions trading program to be effective. Small regions for trading areas would ensure that trades only took place between environmentally-equivalent sources, but if regions are made too small there might be too few sources for an active trading market to develop. For some VOCs sources, and for mobile NOx sources, there would likely be too many sources for either command and control or emissions trading at the user-level, but either could be developed for trades or controls at the manufacturer level (e.g. the manufacturers of vehicles). Pollution taxes or charges (with payments based on periodic tests) might be a preferred option to trading for older vehicles, where trading would be impractical.

Out-of-Province Competition

Pollution taxes can pose competitiveness problems if not imposed on out-of-province competitors for Ontario industries. This could restrict the use of such taxes in the NOx-VOCs case, since many industrial firms and power users face competition from other jurisdictions. Product taxes or charges (e.g. on solvents) would have to be imposed equally on imported and domestic products, and it might be necessary to exempt exports. The abatement cost savings achievable under emissions trading relative to command and control might be a useful competitive edge for Ontario industries if other jurisdictions adopt a command and control approach.

Financial Performance

Since the sources of NOx and VOCs are quite diverse, it is difficult to summarize the financial status of the various sources of these emissions. Care would have to be taken in designing either pollution tax or auctioned permits systems to avoid negative impacts on weaker sectors of the economy.

Private / Public Sector

There might be some resistance from environmental groups to economic instrument approaches that enabled Ontario Hydro, as a public agency, to do less abatement than best available technology would allow.

Interfirm Linkages

The sources of NOx and VOCs cut across a diverse range of industries. An emissions trading program would therefore not begin with the advantages of an existing history of inter-firm trading, as was the case in the leaded gasoline program in the U.S. The exception would be for some vehicle manufacturers that have been involved in joint ventures with non-North American firms.

Economic Growth

The heavy industries that are involved in NOx and VOCs emissions are not generally among the highest growth sectors in Ontario, although there are some exceptions in this regard. Growth in overall energy consumption and vehicle usage could be an important source of both NOx and VOCs emissions. Thus, there may be some advantages to emissions trading programs (quantity-based instruments) that enable regulators to build-in total emissions targets rather than merely standards or pollution taxes for each source.

Monopoly Power

Since major NOx and VOCs sources cut across different industries, monopoly power would not appear to be a problem for emissions trading programs. For pollution taxes, it would be necessary to examine the markets for each of the various products associated with NOx or VOCs emissions to test the extent to which the prices of these products are already elevated due to monopoly power or exceptionally high sales taxes (e.g. on fuels).

Jurisdiction

Jurisdictional issues would not appear to pose an insurmountable barrier in the selection of policy instruments for NOx-VOCs control. It would be necessary to ensure that the outcome of any approach selected was consistent with the targets set in the CCME Management Plan. This might be easier for command and control or quantity-based economic instruments than for pollution tax approaches, since price instruments would have a much more uncertain impact on total emissions levels.

Existing Body of Standards

Since the major initiatives for NOx and VOCs control are still in the design stage, it would not be too late in the process to make use of economic instrument approaches. Indeed, the CCME Management Plan specifically calls for the examination of emissions trading options for existing sources.

Extent of Industry Resistance

Some industries – small paint sprayers, dry cleaners, etc. – could potentially face very high control costs relative to their ability to pay for them. We also understand that a number of Ontario firms have been actively promoting the idea of emissions trading as a cost-effective alternative to command and control policies for NOx-VOCs control. Thus, it appears that emissions trading might be a means of forestalling strong industry resistance to a less-flexible command and control program.

Knowledge of Existing Emissions

Detailed baseline emissions data is essential for the effective use of emissions trading programs. There may be requirements for further modelling to determine the linkages between individual sources of NOx and VOCs and ground-level ozone problems in Ontario. This is particularly the case for mobile sources, according to the CCME Management Plan. This could impede the development of emissions trading programs for some types of sources, although there would appear to be sufficient data to permit the development of a trading program for the largest stationary sources of NOx. In any event, more detailed work on emissions inventories has been incorporated into the first phases of the CCME Management Plan.

Desire to Promote Conservation or Affect Industry Output

Economic instruments may be favoured over command and control in the case of NOx and VOCs, since they will directly create financial incentives for conservation in energy use. This would be consistent with other objectives for government policy in the energy field.

Government Fiscal Policy Objectives

We are not in a position to comment on whether pollution taxes, auctioned permits or subsidies for NOx-VOCs control would be consistent with other government fiscal policy objectives.

As we noted, we have not conducted the detailed research into the ground level ozone problem that would be necessary to apply fully the framework approach and reach a

conclusion on the appropriate policy instrument. The discussion above, based on incomplete information, suggests that an economic instrument approach using marketable emissions permits might be viable for large, existing, stationary sources of NOx. VOCs emissions might be partially addressed using taxes on polluting products, likely as a supplement to command and control requirements. In the case of motor vehicles, there would appear to be no reason not to permit manufacturers to trade emissions performance permits, enabling one manufacturer to sell higher emission vehicles in exchange for another manufacturer exceeding a guideline for average vehicle performance. Taxes on used vehicles might be used to discourage the ownership of older, environmentally damaging cars.

As can also be seen from the NOx-VOCs example, the framework provides a means of assessing the merits and demerits of each instrument in a particular application, but does not reach a final conclusion on how these should be weighed. The Ontario government will have to use its own views on how strongly each criteria should be weighed in practice.

7.3.3 Applications to Other Environmental Policy Areas

Waste Management

Ontario and its major urban areas are confronting an increasing problem in dealing with solid wastes. While household wastes previously flowed to available landfills, appropriate sites are becoming scarce in Southern Ontario, local opposition to new sites is strong, and incineration also faces considerable resistance.

While recycling at curbside is making some headway in reducing solid wastes, new initiatives are planned to encourage a greater reliance on the 3R's: reduction, re-use and recycling.

Price instruments (such as variable rates for garbage pick-up, deposit-refund systems etc.) appear to hold considerable promise in addressing this issue, although negative impacts on existing curbside recycling pickups need to be closely watched. The number of sources is very numerous. The environment is well mixed over a broad area, in the sense that a given kilogram of household waste poses an equivalent pollution problem regardless of the household involved. Urban solid wastes are not highly toxic overall, and objectives would not include complete elimination of wastes flowing to landfills. Charge

or deposit rates could be adjusted over time without difficulty as information is revealed about response elasticities. Finally, the existing regulatory system is not well developed, leaving ample room to integrate the use of price instruments into the overall policy approach.

For similar reasons, deposit-refund (or performance bond) systems would appear to be a promising approach to *supplementing* Ontario's existing command and control hazardous waste management programs. For example, deposits could be charged on industrial or home purchases of motor oil, with refunds being granted upon performance of an appropriate disposal step. Since improper disposal of partially-full containers of paint, solvents or pesticides can also be a problem, deposits could be set on these containers and refunded on return of the empty or partially-full container.

However, the same analysis suggests that pollution taxes would not be an effective *replacement* for command and control in hazardous waste management. For environmental reasons, in view of the toxicity of some waste products, the policy should not permit firms to elect when to dispose of waste properly, as would be the case in a pure price approach.

Quantity-based instruments may also have some applications in solid waste management. For example, Ontario is placing pressure on packaged-goods companies to reduce the quantity of disposable packaging materials they use, and regulations may follow if voluntary compliance fails. Rather than compel each packaged-goods firm to reduce by a constant percentage, the government could allow for trading among firms. This would enable those that can reduce more cost-effectively to undertake a greater share of the abatement, in exchange for payments from other firms. The packaging waste problem meets many of the desired characteristics for trading, including non-toxic discharges, a fairly well-mixed environment, a reasonable number of potential traders among the packaged goods majors, the absence of an existing command and control structure, and the potential for significant cost differences.

Air Pollution Control

The control of sulphur dioxide emissions under the Countdown Acid Rain program is well along the way towards its 1994 deadline. Thus, based on our framework, it might be too late to shift to a completely different regulatory approach. Emissions taxes might also be rejected on the grounds that initial responses to a tax would be difficult to estimate, and political resistance from industry on competitiveness grounds would be strong.

At the same time, other economic instrument approaches could be used as a supplement to command and control in this area, since the objectives are for control rather than elimination of discharges. Dewees (1990) shows how emissions trading could be grafted on to the existing command and control policy, although in view of the timing of such a move and the small number of sources, it is not clear that there would be significant trading. Should the Ministry wish to promote additional abatement beyond the Countdown program, one might envision a system of permit trading that would extend to some of the smaller sources. Some of these sources might be able to buy credits generated by additional abatement by the major sources.

Addressing the greenhouse effect globally and in Canada would appear to be an issue suited for a mix of instruments, based on our framework, should international cooperation be achieved. The lack of an existing command and control structure creates the possibility for the use of innovative approaches. Globally, one might wish to allow countries to "trade" greenhouse gas emission targets in view of the large cost differences in abatement. For example, it might be cheaper for developed countries to pay other countries the cost of abandoning the use of dirty coal than to make equivalent reductions in emissions domestically.

Within Canada, in view of the large number of sources, price instruments (taxes on fuels, incentives for conservation, etc.) might be necessary to deal with some aspects household behaviour. Either command and control or economic instrument approaches could be used to deal with smaller numbers of major industrial sources (e.g. through regulations on equipment makers, builders, etc. in terms of fuel efficiency, CFC reductions). Again, since overall levels as opposed to control at each source is the objective, even for these smaller numbers of major sources there is reason to believe that the flexible responses allowed through economic instrument approaches would be advantageous from an economic efficiency perspective.

Other air pollution control problems, including the control of odours or lead emissions, for example, have important local pollution dimensions. Except as supplementary penalties or incentives, economic instruments are likely to be inappropriate in such cases, which require tight controls on specific local sources.

Water Pollution Control

The BOD control case examined in Chapter 3, while demonstrating some inefficiencies in command and control, also points to an only limited potential for the use of economic instrument approaches. Marketable permits would be inappropriate in most cases due to the lack of multiple sources on the same body of water. However, trading appears to hold promise for BOD and TSS in those cases where mills are on the same river, or between a mill on a lake and a mill on a river feeding into the lake (where the seller of the permit is the latter). Pollution taxes would have to be set very high to induce abatement, and the current paper industry financial performance is not strong.

In general, because of the local nature of water pollution control problems, the different chemical composition of effluents, and concerns over toxic effluents, economic instruments appear to hold less promise in this area than in solid waste or air pollution management. There most likely use would be as supplements to command and control, to provide a financial incentive (subsidies or charge avoidance) for meeting or exceeding standards. Other opportunities may lie with pricing instruments that instill appropriate conservation efforts in water usage, by replacing fixed water charges with variable ones based on usage.

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GLOSSARY

BATEA - an approach that sets abatement standards based on the performance of the Best Available Technlogy Economically Achievable.

Biochemical Oxygen Demand (BOD) is a measure of the biodegradable organic waste discharged into water systems, in terms of its impact on the amount of dissolved oxygen in the water, and thus on the ability of the water to sustain life.

Carbon dioxide (CO_2) – a gas emitted in the burning of fossil fuels by utilities, industries and vehicles. Rising concentrations of carbon dioxide in the atmosphere as a result of these emissions (and the destruction of CO2 absorbing forests) have been cited as a potential source of global warming, through the "greenhouse effect".

Chlorofluorocarbons (CFCs) and Halons (brominated fluorocarbons) are industrial chemicals that have been identified as contributors to the thinning of the stratospheric ozone layer that protects the earth's surface from damaging solar ultraviolet radiation. CFCs are also a contributor to global warming through the "greenhouse effect."

DOE – the federal Department of the Environment, currently known as Environment Canada

Efficiency - the extent to which resources (labour, capital equipment etc.) are deployed in a manner that maximizes economic welfare. Efficiency implies that the optimal mix of goods and services (taking into account the negative impacts of pollution) are produced, and that each product (including environmental protection) is produced at a minimum cost.

Elasticity - a measure of the percentage response in one variable (e.g. demand) induced by a percentage change in another variable (e.g. price).

MISA - the Municipal-Industrial Strategy for Abatement program of the Ontario Ministry of the Environment, designed to significantly tighten provincial regulations on wastewater effluents.

MOE – the Ontario Ministry of the Environment

Nitrogen oxides (NOx) are gases emitted primarily in the combustion of fossil fuels by vehicles, and industrial and utility boilers. NOx emissions, along with VOCs are linked to the formation of ground level ozone, a cause of respiratory health problems, crop damage and materials damage. They are also a contributor to acid precipitation.

Organochlorines are organic chemicals containing chlorine, which can be highly toxic and persistent in the environment. The pulp and paper industry is one current source of these effluents.

Sulphur Dioxide (SO_2) – a gas discharged in combustion processes (particularly coal burning) for thermal electric utilities, metal smelters, steel manufacturers, refineries, paper mills, motor vehicles and home heating. It is linked to acid precipitation (in

turn linked to damage to acquatic life, trees and buildings) and, in high ground level concentrations, to respiratory problems and crop damage.

Total Suspended Solids – the various particles or pieces of solid materials in liquid effluents from industries and municipalities. In the case of the pulp and paper industry, for example, TSS is largely wood fibres.

Volatile Organic Compounds (VOCs) are a wide range of chemicals released into the atmosphere from industrial combustion processes and from the evapouration of various liquid fuels, solvents and organic chemicals. VOCs are implicated in the reactions that form high concentrations of ground level ozone.